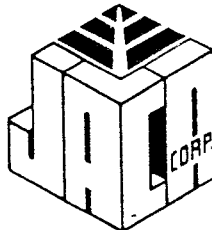


**ENVIRONMENTAL  
CONSULTANTS  
AND  
ENGINEERS**

August 1988

**Sampling and Analysis Plan  
for  
CryoChem Site  
Earl Township, PA**

Submitted By:



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**300202**

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## 1.0 INTRODUCTION

The Sampling and Analysis Plan (SAP) describes activities to be undertaken as part of the Remedial Investigation/Feasibility Study (RI/FS) at the CryoChem site in Worman, Pennsylvania. This plan has been derived primarily from the April 1988 Draft Revised SAP prepared by Roy F. Weston, Inc. The purpose of the SAP is to identify specific field investigations, sampling, analysis, and quality assurance/quality control procedures which will be utilized during the RI/FS. The SAP consists of five chapters describing the site's history and condition, the project objectives and scope, field protocols, the site management plan, and quality assurance. The Appendix contains Standard Operating Parameters (SOPs) for field instrument operation and calibration. In addition, the activities described by this SAP are presented in the site Work Plan, and the health and safety requirements are specifically detailed in the site Health and Safety Plan.

### 1.1 Site Location

The CryoChem site is located in the Village of Worman, Earl Township, Pennsylvania which is approximately three miles west of Boyertown, Pennsylvania on Route 562 (see Figure 1-1). The site is approximately 19 acres in size and is situated in a semi-rural area of Berks County. CryoChem, Inc., a metal fabrication company, is the owner and operator of the site. CryoChem's facilities consist of a workshop area, office buildings, and a warehouse which are situated on the southern four acres of the site (see Figure 1-2).

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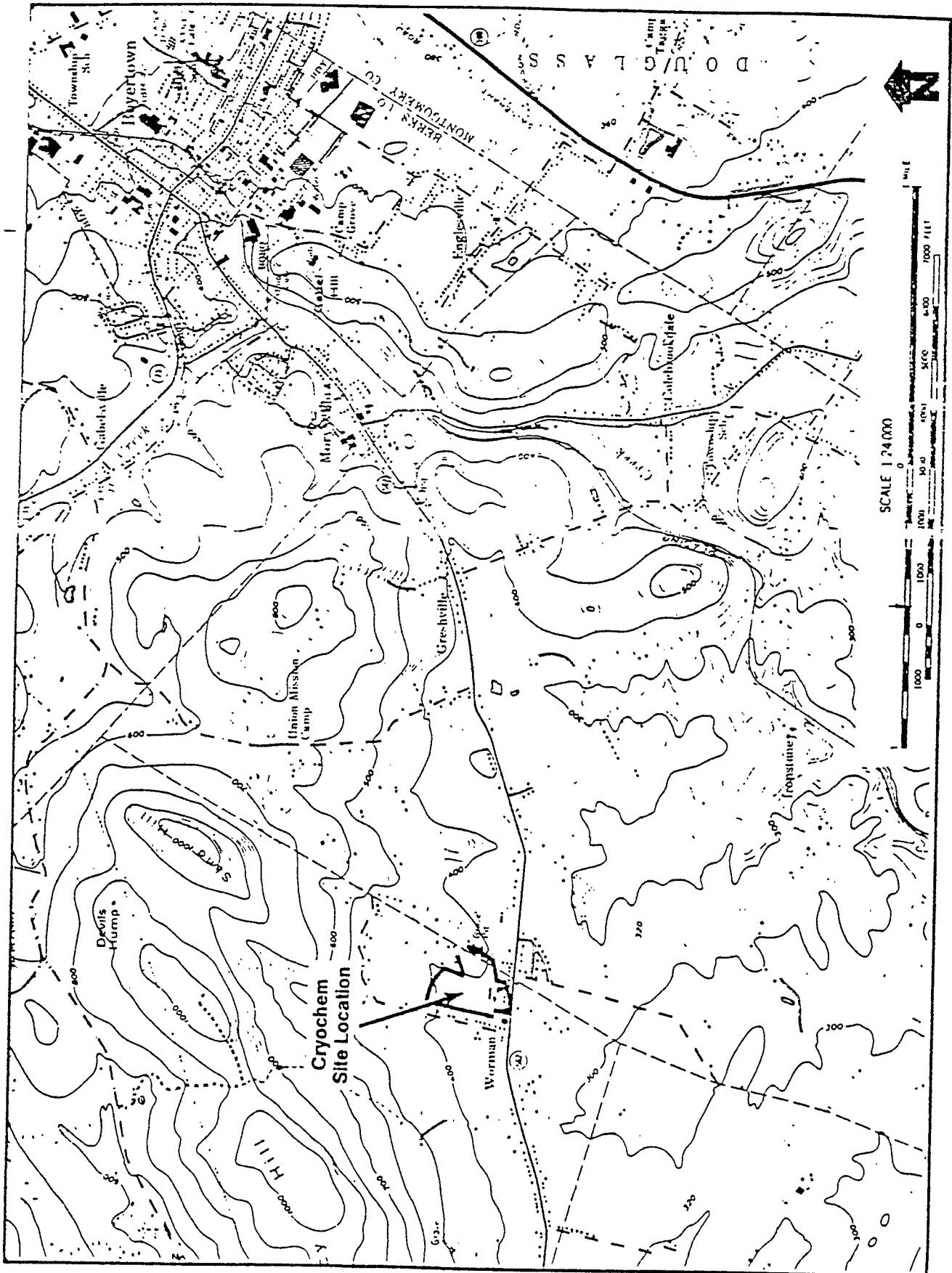


FIGURE 1-1 SITE LOCATION MAP, CRYOCHEM, INC.  
EARL TOWNSHIP, PA

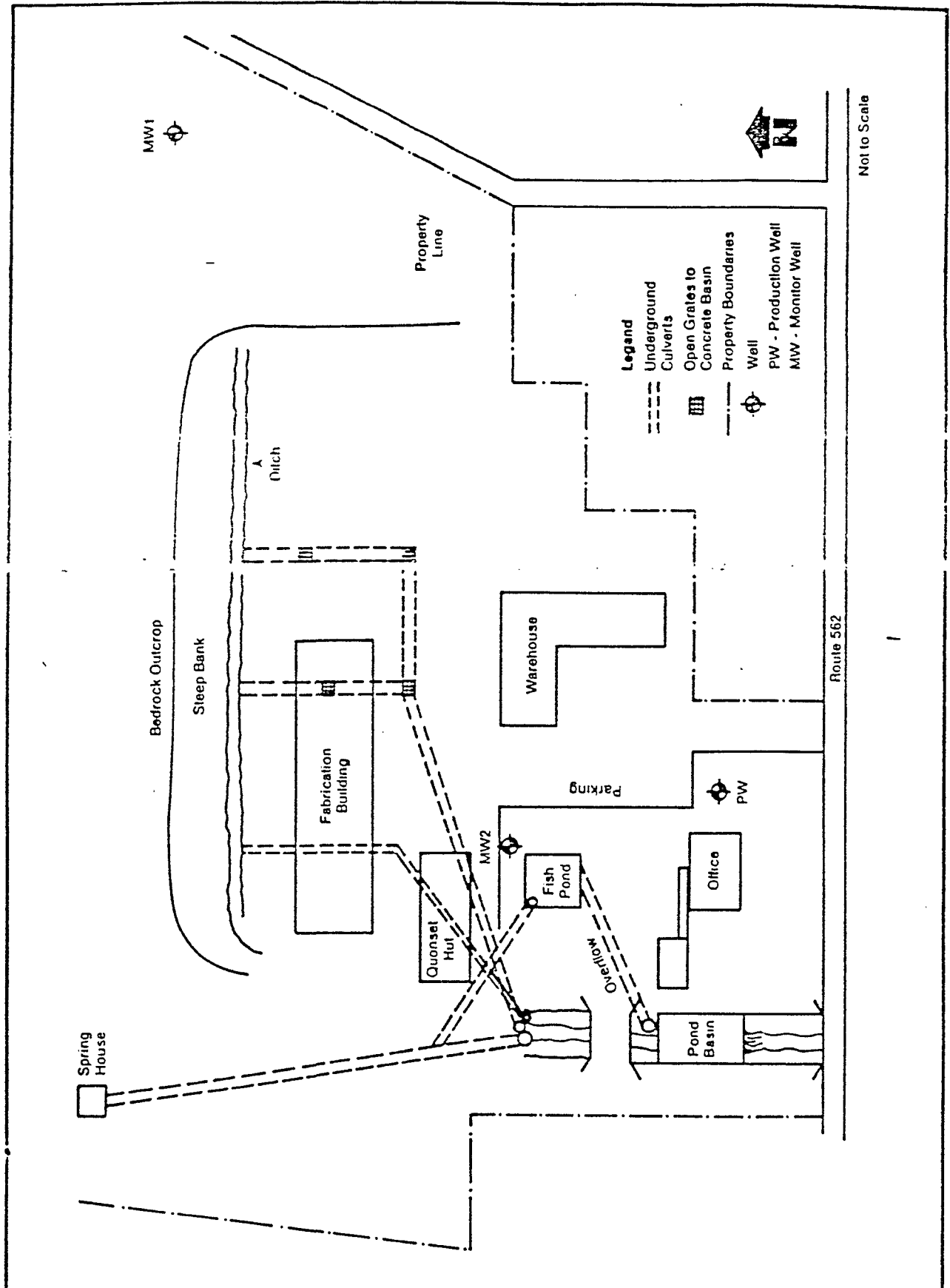


FIGURE 1-2 SITE MAP

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## 1.2 Site History

CryoChem has been in operation since 1962. Part of the metal fabrication process employed by CryoChem included the use of Chlorathane, a commercial chemical solvent comprised of 1,1,1-trichloroethane, to wipe a dye that was used to detect possible faulty welds on metal products. The solvent was reported to vaporize from the metal products. Use of Chlorathane was reported between 1970 and 1982 at a rate of 2 to 3 55-gallon drums per year (CryoChem letter to EPA). In 1981 PA DER and other laboratories sampled drinking water wells near the site after residents complained about odors. Levels of 1,1,1-trichloroethane (TCA), trichloroethylene (TCE), and tetrachloroethene (PCE) were detected in the samples. In July 1982, CryoChem reported that a one-time spill of Chlorathane had occurred into the shop drain in the Fabrication building. The shop drain empties into a surface water discharge that eventually leaves the site untreated (see Figure 1-2). Neither the time of the spill nor the amount of Chlorathane spilled was reported. The spill was acknowledged only after home wells near CryoChem were sampled.

During the summer of 1982, PA DER sampled locations on the CryoChem site including surface water runoff, water drains, and ground water, and found elevated levels of TCA on-site. PA DER notified CryoChem that the facility was in violation of the Clean Streams Act of 1937 and made recommendations that CryoChem discontinue use and dispose of all Chloroethane

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(TCA), clean out and seal off the shop drain, properly dispose of any wastes generated, construct a concrete pad under the existing above-ground fuel tanks, and retain the services of a qualified hydrogeologist to submit a work plan and a PPC (Preparedness, Prevention and Contingency) Plan.

CryoChem complied with PA DER's recommendations and in April 1983 submitted a report of an investigation conducted by Gilbert/Commonwealth at the site. The investigation included soil sampling and the installation of two monitoring wells and found TCA contamination in the ground water and soil. In December of 1983, the EPA Region III FIT teams sampled ground water, surface water, and sediments both on- and off-site. Their findings were reported in May 1985. Also in May 1985, FIT prepared an HRS for the CryoChem site. In March 1987, the RI/FS work assignment was made to the REM II team.

### 1.3 Geology

The CryoChem facility lies in the Reading Prong section of the New England Physiographic Province of Pennsylvania. The Reading Prong section is comprised of Precambrian crystalline and Paleozoic rock formations which form a belt of hills and ridges starting near Reading, Pennsylvania and continuing eastward through New Jersey, southeastern New York and western New England.

The Leithsville Formation, a black to dark gray crystalline limestone with quartz seams, underlies the southern and northwestern part of the

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site. The thickness of this unit in the study area is unknown. A lobe of the Hardyston Formation, also of unknown thickness at the site, forms a ridge beneath the northeastern part of the facility. The Hardyston Formation at the site consists of a light gray to buff quartzite near the surface which turns to a darker gray at depth. Existing maps indicate that the contact of the Hardyston and Leithsville behind the Fabrication building on-site is a fault or displacement (Figure 1-3).

The two monitor wells that were drilled at the site during the Gilbert/Commonwealth study indicate that the soil profile over the Leithsville Formation is approximately 40 feet thick and consists of clay, sand and gravel. The known soil profile (Gilbert/Commonwealth report) over the Hardyston Formation ranges from 0 (outcrop) to 12 feet (MW-1) and consists of silty sand with angular rock fragments. Gilbert/Commonwealth's drill logs indicate that the soil overburden at the site may have a large percentage of sand, gravel, and rock fragments which may result in highly permeable, well-drained soils.

#### 1.4 Topography

The operational part of the site (southern 4 acres) is level to gently sloping toward the south. Behind the Fabrication Building the land rises abruptly (from the 350 to 440 feet above mean sea level) to the northeast, forming a forested hill. To the northwest is a gently sloping

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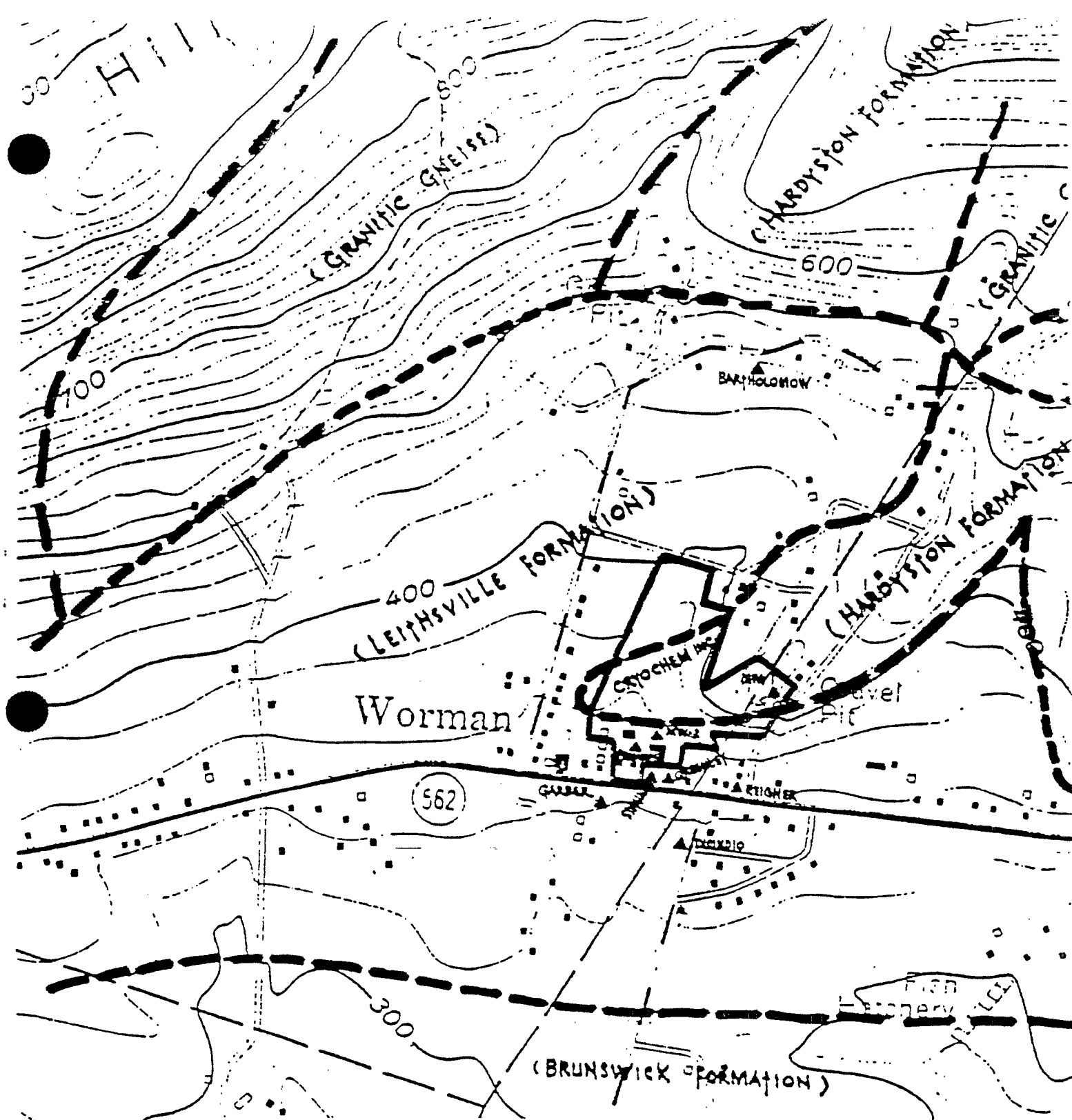


FIGURE 1-3

GEOLOGIC MAP OF WORMAN AREA

- Enlargement of USGS Boyertown Quadrangle
- Geology from PA DER Map #61, 1981
- Figure Copied from EPA Report R-585-9-4-01

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open field. The topography is controlled by the geology, with the Hardyston quartzite forming the hills and ridges and the Leithsville limestone forming the gently sloping land (see Figure 1-1).

#### 1.5 Ground Water Hydrology

Ground water movement in the area appears to be associated with fractures in the quartzite and limestone based on previous on-site investigations. Gilbert/Commonwealth has estimated ground water flow to be in a southerly direction across the site. However, this direction was determined by using a spring discharge and two monitor wells on-site which were given estimated elevations based on data from a USGS topographic map. Since it is not known if the spring discharge is an accurate indication of regional ground water flow, the information presently available is insufficient for accurate determination of ground water flow direction. No previously recorded ground water elevations have been found other than one set of measurements made on the three monitor wells in September of 1983.

The following considerations will be addressed during the RI in order to determine ground water characteristics:

- o The well drained soils and the nature of the spread of contaminants to the ground water, reported in previous studies, indicates some degree of interconnection between the soil overburden and the underlying bedrock.

- o The variability in rock types and aquifer systems. Geophysical surveying will not be performed in the initial phases of work to try and distinguish various rock types since surface expression of the sandstone/carbonate rocks is well developed and would affect geophysical surveying.
- o The limestone bedrock may have solution cavities and pathways along fracture zones which may have an effect on the migration (speed and extent) of contaminants.
- o The possibility of a perched water table aquifer in the overburden must be investigated.
- o The effects of on- and off-site pumping on the aquifer and/or the migration of contaminants is not known at this time.
- o The effects on the movement of ground water and/or contaminants by the lithologic change between the soil profile and bedrock and/or quartzite and limestone are not known.
- o The amount of water leaving the site through surface run-off or spring discharge is unknown.

#### 1.6 Surface Water Hydrology

Surface water on-site consists of runoff that originates behind the Fabrication Building and is channeled toward the southwest through

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underground culverts. This surface runoff combines with a spring which discharges from the northwest and is channeled southward. The surface water then flows into a ponded basin situated next to the office buildings. The basin discharges into the natural surface drainage across Route 562. The spring discharge also feeds a fish pond on-site. The overflow from the fish pond discharges to the stream upstream of the ponded basin. Surface water drainageways are shown in Figure 1-2.

#### 1.7 Properties of Contaminants

The contaminants of concern at the CryoChem site include:

- o 1,1,1-Trichloroethane (TCA)
- o 1,1-Dichloroethene (DCE)
- o 1,1-Dichloroethane (DCA)
- o Trichloroethylene (TCE)
- o Tetrachloroethylene (PCE)
- o Chlordane and PCB-1260
- o Metals
- o Methylene Chloride

These contaminants were identified from analyses made at various times for all HSL parameters.

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#### 1.8 SITE CONTAMINATION SURVEY

From the sample results reported in previous studies, there is evidence that:

- o The TCA contamination is not limited to the shop drain, it was also found in surface water behind the Fabrication Building and in the ground water on-site.
- o DCE and DCA were detected in ground water both on-site and off-site.
- o While there was no TCE detected on-site, it has been detected in low levels in the household wells to the southeast of the plant, and in higher levels to the northeast of the plant.
- o PCE was detected in test pits on-site and in the cluster of homes (ground water) to the southeast of the site. One of the homes near the site is reported to have once been a wood refinishing business which may have used paint removers containing PCE. This has not been confirmed.
- o Chlordane, a pesticide, was detected in several on- and off-site wells and in stream sediment areas.
- o PCBs were detected on-site in a surface water and sediment sample.

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- o Metals are not major parameters of concern because they have never been observed in abnormally high concentrations except in the monitor wells which probably picked up iron from the rusted well casing and clays from soil and groundwater sediments. Nevertheless, they will be analyzed in the preliminary sampling.
- o Methylene chloride is not a major parameter of concern because the four instances where it was observed were at such levels that the laboratory questioned their presence. The only substantial concentration was 63,000 ug/l which the laboratory believes to be a lab error or lab contamination. Nevertheless, it will be sampled for in the full HSL-VOA test.
- o Chlorobenzene was only found once in one well and at a very low level. Therefore it is not a major contaminant of concern but will be analyzed for in the HSL-VOA test.

A summary of site contamination is shown in Table 1-1.

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TABLE 1-1  
CONTAMINANTS OF CONCERN (ppb)  
SUMMARY TABLE

1,1,1-Trichloroethane (TCA) found at:	
Surface water behind Fabrication Building	- 38
Surface water after shop drain	- 330
Downgradient on-site well	- 3.6
Production well	- 350
Off-site home wells	- 0-560
Soils on-site	- 2.6-6.4
Trichloroethylene (TCE) found in off-site homes (0-28 ppb) but not on-site.	
Tetrachloroethylene (PCE) found at:	
Soil samples from test pits on-site	- 10.1-13.8
Off-site home wells	- 0-2.6
1,1-Dichloroethene (DCE) found at:	
Surface drainage after shop drain	- 2.9
Production well	- 6.6
Off-site home wells	- 0-130
1,1-Dichloroethane (DCA) found at:	
Surface drainage after shop drain	- 2.1
Downgradient well	- 2.9
Production well	- 12
Off-site home wells	- 0-33
Chlordane found at:	
Production well	- 0.40
Off-site home wells	- 0-0.34
Stream sediment	- 52
Perchloroethene (PCE) residential well	- 0-2.6
PCB-1260 found at:	
Surface drainage behind Fabrication building	- 0.14
Stream sediment	- 52
Methylene Chloride found at:	
Upgradient monitor well	- 63,000
Chlorobenzene found at:	
Production well	- 1.9
Metals found at both monitor wells. (Lead and selenium above the MCL)	

Sources of data from various studies compiled in JACA February 1988 study.

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## 2.0 REMEDIAL INVESTIGATION

The objective of the remedical investigation (RI) is to generate the information needed to evaluate the feasibility of appropriate remediation strategies for the CryoChem site. Specific objectives include:

- o Determining the potential source(s) of the contaminants and evaluating at least the eight possible contributors identified in the Feb. 1988 study by JACA Corp.
- o Determining if significant soil contamination exists at the site, and if so, determining the approximate horizontal and vertical extent of the material that would need to be remediated.
- o Determining subsurface stratigraphy relative to contaminant migration pathways.
- o Determining horizontal and vertical ground water flow rates and contaminant migration patterns relative to the subsurface stratigraphy and the potential for off-site contaminant movement.
- o Determining the nature, magnitude, and extent of any ground water contamination relative to the source area and potential sensitive receptors.
- o Determining the quality and quantity of contaminated sediments, site discharges and other surface water bodies.

Table 2-1 summarizes potentially applicable response actions; technologies to implement those actions; and the technical, institutional,

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TABLE 2-1

## IDENTIFIED POTENTIAL TECHNOLOGIES

## CRYOCHEM

RESPONSE ACTION	TECHNOLOGY	TECHNICAL CONSIDERATIONS	INSTITUTIONAL CONSIDERATIONS	PUBLIC HEALTH AND ENVIRONMENTAL CONSIDERATIONS
NO ACTION	Periodic monitoring and sampling	Continuous monitoring and sampling	Publicly unacceptable	Does not prevent migration of contaminants or remediate environment or health threat
ALTERNATIVE WATER SUPPLY	Municipal water source/ bottled water supply	Effectively remediates public health concerns; distance to nearest source; construction costs	Does not remediate contaminated aquifers; must include other remedial action	Fulfills public health concerns; does not address environmental concerns
POINT OF USE TREATMENT	Multiple activated carbon/ reverse osmosis systems	Feasibility to address all contaminants; implementation of systems; requires maintenance and monitoring	Does not remediate contaminated aquifers; must include other remedial action	Public consent; fulfills public health concerns; does not address environmental concerns
GROUNDWATER CONTAINMENT	Groundwater pumping	Prevents migration with hydrologic barriers; site conditions must be suitable	NPDES standards apply for discharge	Removes contaminated groundwater; discharge quality
	Interceptor drain/ barrier wall	Prevents migration by interception; groundwater depth; vertical containment; bottom sealing	Operational safety; treatment and storage of contaminated groundwater	Reduces potential for lateral migration

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TABLE 2-1

## IDENTIFIED POTENTIAL TECHNOLOGIES

## CRYOCHEM

RESPONSE ACTION	TECHNOLOGY	TECHNICAL CONSIDERATIONS	INITIATIONAL CONSIDERATIONS	PUBLIC HEALTH AND ENVIRONMENTAL CONSIDERATIONS
GROUNDWATER AND SURFACE WATER TREATMENT	Activated carbon	Proven technology; meeting reg.; capital costs	Disposal or regeneration of carbon	Contaminants removed; however, residuals must be handled
	Biological treatment	Proven technology; attainable levels; pilot studies necessary	Disposal of waste sludge	Same as above
	Coagulation/ filtration/ sedimentation	Proven technology for metals and solids removal; combination with other treatment necessary	Disposal of sludge	Same as above
	Ion exchange	Effective for metals; fouling problems; high capital costs	Disposal or regeneration of resins	Same as above
	Reverse osmosis	Variable performance for organics; pretreatment required for fouling; high costs		Same as above
GROUNDWATER AND SURFACE WATER TREATMENT	Ozonation	Proven technology for oxidation of metals; can be used as oxygen source for biological treatment of organics	Safety concerns during operation	Same as above
	Air stripping	Proven technology for volatile organics; excellent removal rates; emission control; fouling problems	NPDES standards apply for discharges; air permit requirements	Contaminants removed; vapor phase abatement

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TABLE 2-1  
IDENTIFIED POTENTIAL TECHNOLOGIES

CRYOCHEM

RESPONSE ACTION	TECHNOLOGY	TECHNICAL CONSIDERATIONS	ENVIRONMENTAL CONSIDERATIONS	PUBLIC HEALTH AND ENVIRONMENTAL CONSIDERATIONS
SURFACE WATER CONTROL	Site regrading/surface control/revegetation	Reduces infiltration by diverting flow from contaminated soils; should be used with cover system	Contamination remains on-site as listed waste	Reduces infiltration and leachate generation; does not eliminate potential transport of contaminants
	Soil capping system	Requires multilayer system	Must meet standards for covers	Provides control of surface water runoff; does not remove contaminants
SOIL/SEDIMENT TREATMENT AND DISPOSAL	Excavation, treatment and replacement	Requires monitoring of soil and groundwater	Attainable levels; must meet operating and design standards	Confirmation of sufficient treatment; safety in operations
	Excavation and off-site disposal	Requires soil conditions for application; dependent on soil volume; high costs	Must be disposed at EPA approved facility, pretreatment of soils may be necessary	Confirmation of sufficient removal; safety in operations
	Thermal stripping	Requires excavation of soils and processing; requires pilot testing to confirm applicability; high capital costs	Listed residue may be returned to site with approval; air permit	Overall effectiveness for all wastes is not known; emission abatement
	Incineration	Low BTU value of soils results in large ash residue; high capital costs	Listed ash disposed or returned to site; air permit	All contaminants are oil destroyed; possible emission concerns and operational safety
In situ biotreatment or chemical injection		Proven effective for some organics; minimal disturbances to site; requires bench-scale studies	Attainable levels	Overall effectiveness for specific sites unknown; minimal land disturbances; limit exposure

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TABLE 2-1  
IDENTIFIED POTENTIAL TECHNOLOGIES  
CRYOCHEM

RESPONSE ACTION	TECHNOLOGY	TECHNICAL CONSIDERATIONS	INSTITUTIONAL CONSIDERATIONS	PUBLIC HEALTH AND ENVIRONMENTAL CONSIDERATIONS
SOIL/SEDIMENT TREATMENT AND DISPOSAL	Soil flushing	Proven effective for some organics; treatment effectiveness dependent on soil type; requires bench-scale testing and groundwater treatment	Attainable levels	Remove portion of contaminants
	Volatilization	Proven effective for some volatile organics; requires ideal soil conditions; pilot testing required; emission control	Attainable levels; air permit	Remove portion of contaminants
	Vitrification	Not yet proven effective for organics; in developmental stages		
	Sediment sealing	Effective for containment of sediment contaminants; requires bench-scale/pilot testing		Prevents further migration of contaminants

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public health and environmental considerations involved with each action. These technologies have been identified based upon the available site data.

The RI field investigation will be completed in three phases so that information can be analyzed as it is collected, and utilized for the next phase of the investigation and/or feasibility study. Each phase is summarized as follows:

#### Phase I

The objectives of Phase I are to further evaluate existing site background information concerning past disposal practices and geology, to delineate the extent and levels of contamination of off-site residential drinking water (ground water), to identify potential environmental receptors, and to investigate evidence of on- and off-site sources of contamination.

#### Phase II

The objectives of Phase II are to confirm earlier sampling results, determine extent (both horizontal and vertical) of possible soil contamination, evaluate contaminant migration pathways, and better define aquifer characteristics. Information collected during Phase II will better define the remedial alternatives to be evaluated.

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### Phase III (Optional)

The objectives of Phase III are to further define aquifer characteristics for feasibility studies, and confirm contaminant levels found in Phases I and II. Phase III will be performed at EPA's option based on the results of Phases I and II.

## 2.2 RI Activities

### 2.2.1 Phase I

The Phase I investigation will include:

- o Evaluation of additional background information.
- o Interpretation of historical aerial photographs.
- o Analysis of stereo aerial photographs to locate fracture traces using stereo glasses that may aid in monitor well placement.
- o Inventory of residential wells within a 1/2 mile radius of the CryoChem site.
- o Gather general information on construction and use of all production wells in the area.
- o Sampling and analysis of selected residential wells.
- o Screening of on- and off-site soils for contamination using soil gas analysis.
- o Preparation of a topographic map.

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- o Walkthrough by a field biologist to obtain general qualitative descriptions of habitats, vegetation type, and potential environmental receptors. This is a general description, thus wetland areas will not be field flagged unless later needed for encroachment concerns except that the CryoChem property will have its wetlands delineated.
- o Detailed field mapping of geologic out crops on and off site to identify formation contacts and to identify strike, dip, etc. of the strata. This may be revised after well cutting and core information has been gathered.
- o Analysis of Phase I data for planning of Phase II activities.

#### 2.2.2 Phase II

The Phase II investigation will include:

- o Installation of monitor wells in clusters including:
  - Six shallow wells in unconsolidated (soil) material
  - Five bedrock wells to first fracture zone yielding sufficient water for sampling.
- o In-situ description of borehole geology by coring and running temperature, caliper and video camera borehole surveys prior to completion of bedrock wells.
- o Soil sampling and monitor well installation.
- o Surface soil sampling based on Phase I data.
- o Surface water sampling.

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- o Stream sediment sampling.
- o Ground water sampling of monitor wells.
- o Slug and packer testing on selected monitor wells.
- o Leak test of the shop drain system.
- o Installing monitoring instrumentation to determine the variance of the local ground water use (water level recorders) and the amount of surface water and spring discharge flows leaving the site.
- o Gather detailed information on use of all production wells in the study area.
- o Confirmation round of on- and off-site sampling will be performed to confirm analysis results and possibly note fluctuations over time.
- o Collect rain data and periodic sampling of the production well on-site and stream discharge to determine the effects of precipitation of contamination, ground water, and surface runoff levels.
- o Aquifer (pumping) test.
- o Conduct treatability and/or pilot testing of groundwater treatment systems.
- o Analyze data to determine scope of Phase III. Specifically, determine the need for biota sampling and additional environmental sampling. This second round of sampling, if necessary, would be used to determine need for laboratory bioassays, in situ toxicity testing, or benthic surveys in Phase III.

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### 2.2.3 Phase III (Optional)

Should it be deemed necessary, Phase III investigation will:

- o Confirmation round of on- and off-site sampling with adjustments based on Phase I and II to incorporate concerns of seasonal fluctuations and/or abatement system requirements.
- o Possible sampling of any on- and/or off-site suspected contamination sources identified during Phase I and/or II.
- o Geophysics to investigate on-site subsurface features or other potential off-site sources.
- o Biological sampling.
- o Additional treatability and/or pilot testing.



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### 3.0 FIELD PROTOCOLS

The following sections describe the objectives, scope, protocols and equipment needed to conduct field activities during the RI. Table 3-1 is an outline of decontamination procedures to be used throughout the project. Table 3-2 outlines the samples to be collected, QA/QC samples, and the parameters for analysis. In each sampling task, the parameters of interest are based on earlier sample results. Full HSL parameters will only be analyzed for a percentage of each sampling task since base neutrals and acid extractables levels were not significant in earlier sampling efforts. For exact number of HSL analyses see Table 3-2. A full HSL Analysis consists of VOA, BNA, pesticides, PCB's, metals, and cyanide.

Sections 3.1 and 3.2 cover Phase I field activities and Sections 3.3 through 3.11 cover Phase II activities. Section 3.12 describes procedures for sample packaging and shipment.

#### 3.1 Domestic Well Sampling

##### 3.1.1 Objectives

Houses near the site will be sampled to determine the levels and extent of ground water contamination near and potentially migrating from the site. This data will be used to identify a basis for implementing a possible Expediated Response Action (ERA).

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TABLE 3-1  
DECONTAMINATION WASH PROCEDURES†

<u>Item</u>	<u>Frequency</u>	<u>Decontamination Procedure</u>
Drill rig and drill stems, bits etc.	Between each bore-hole	1. Tap water rinse* 2. Steam cleaning
Split spoons for analytical samples	Before each sample	1. Tap water rinse* 2. Alconox and tap water scrub 3. Tap water rinse* 4. Acetone wipe 5. DI water rinse
Bailers/Soil sampling equipment	Before each sample	1. Tap water rinse* 2. Alconox and tap water scrub 3. Tap water rinse* 4. Acetone wipe 5. DI water rinse
Pumps	Before each bore-hole	1. Tap water rinse* 2. Alconox and tap water scrub and purge 3. Tap water rinse and purge* 4. Acetone wipe 5. DI water rinse 6. See note below**
Water level probe, pH, conductivity, and temperature probe	Before each sample	1. Thorough DI water rinse after each use
Transducers	Before each bore-hole	1. Tap water rinse* 2. Alconox and tap water scrub 3. Acetone wipe 4. DI water rinse
Soil gas probes	Before each sample	1. Pressurized air purging

†The procedures outlined are general steps described in the RCRA Ground Water Monitoring Technical Enforcement Guidance Document (U.S. EPA 1986) which will be the reference used for this study.

\*Tap water refers to Public Water System water.

\*\*Note: Pumps used for purging monitor wells will have dedicated safety ropes which will be removed after each use, washed with a tap water rinse and stored in labeled plastic bags for later use in the same well. Pump and teflon tubing will be washed on the outside and then flushed by placing in a tank of wash water. Flushed water will be stored for proper disposal as described in Section 3, page 4.

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TABLE 3-1

(continued)

DECONTAMINATION PROCEDURES DETAIL

Sample Bottles:

- All sample bottles will be cleaned at the laboratory (see QA/QC Plan), capped and boxed for JACA personnel to deliver to the site.

Soil Probe:

- The inside of the soil probe will be blown out with compressed air to remove gases and clean the entry slots.
- The outside of the probe will be wiped with a clean rag and Alconox solution. The rag will be placed in a plastic bag and held on site in a drum labeled for site waste.

Soil Sampling Trowels, Shovels and Hand Augers:

- The stainless steel trowels etc. will be wiped with a clean rag and nitric acid solution, followed by Alconox then rinsed with acetone and distilled water. The rags will be disposed of in the on-site drum.

Monitoring Well Test Pumps, Bailers and Slugs:

- All sampling equipment will be kept on clean tarps to prevent contact with the soil.
- The outside of the sampling pumps and entire bailer assemblies will be wiped clean with a nitric wash followed by an acetone wipe and distilled water rinse.
- The pump will then be purged by pumping water from a clean water tank into a waste water tank kept on site. "Clean" water will be obtained from a public drinking water supply.

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TABLE 3-1  
(continued)

Drilling Equipment

- After completing each hole, all drill cuttings and water will be stored on site in clearly labeled containers. Containers for all waste containment will be leakproof and consist of either 55 gallon drums, plastic tanks or steel skid tanks. Large quantities of liquid will be stored in tanks on trailers which will be kept in the guarded CryoChem site. All containers will be labeled with permanent marking pens or spray paint and stored and catalogued in a predictable orientation.
- Those portions of the drill & rig that came in contact with the earth will be steam cleaned. The waste water will be stored on site in clearly labeled containers as stated above.

Boots/Clothing

- Tyveck suits and rubber gloves will be disposed of into specially marked 55 gallon drum containers kept on site.
- Rubber boots and heavy gloves will be washed in tubs with Alconox solution. The wash water will be stored on site in plastic tanks.

Waste Storage Containers

The contents of all containers used to store wastes created on site will be analyzed for contamination. If concentrations of contaminants are found above acceptable drinking water levels or are considered a hazardous waste, the waste materials will be properly disposed of or more likely treated on-site. Since the contaminants of concern are primarily volatile organics in relatively low concentrations, aeration stripping will most likely be performed on-site. Any container which held hazardous material will be air dried or steam cleaned after emptied.

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TABLE 3-2  
SAMPLING PARAMETERS

<u>Media</u>	<u>Projected Number** of Samples</u>	<u>Analyses</u>
<u>SOIL</u>		
Field surface soils	25*	HSL-VOA, Pesticides, PCBs, Metals (2 of 25 for full HSL**** scan and analysis of remaining samples for standard HSL parameters)
Monitor wells and/or soil borehole	50*	HSL-VOA, Pesticides, PCBs, Metals (up to 11 of 50 samples will be analyzed for full HSL**** scans)
	22*	Organic carbon content, moisture content (Lab). Soil particle size distribution, and OSCS classification (Soils Lab)
<u>SEDIMENT</u>		
Stream and pond	6	HSL-VOA, Pesticides, PCBs, Metals (2 of 6 are full HSL**** scans)
<u>WATER</u>		
Surface water:	12	HSL-VOA, Pesticides, PCBs, Metals (2 of 12 are full HSL**** scans) Temperature (field) pH (field and lab) Conductivity (field and lab) Hardness, dissolved oxygen content, total dissolved solids, suspended sediment, total organic carbon, alkalinity

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TABLE 3-2  
(continued)

<u>Media</u>	<u>Projected Number** of Samples</u>	<u>Analyses</u>
<u>WATER (continued)</u>		
Ground Water:***		
Monitoring and Production Wells	14 (2 rounds)	HSL-VOA,+ PCBs,+ Pesticides, Metals (Total and Soluble) (3 of 14 will be full HSL**** scans) Temperature (field) pH (field and lab) Conductivity (field and lab) Alkalinity, TOC
Residential wells	25	HSL-VOA, Pesticides, PCBs, Total Metals (5 of 25 are full HSL**** scans) Temperature (field) pH (field and lab) Conductivity (field and lab) Alkalinity, TOC
<u>WASTE</u>		
On-site well installation (drill cuttings, purge and decon water and protective clothing)	11	Solids HSL organics (VOA, BNA, pesti- cides, PCBs) HSL inorganics Toxicity characteristics Leachate Procedure (TCLP)

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TABLE 3-2  
(continued)

<u>Media</u>	<u>Projected Number** of Samples</u>	<u>Analyses</u>
<u>WASTE</u> (continued)		
	11	Liquids HSL organics (VOA, BNA, pesti- cides, PCBs) HSL inorganics pH (field and lab) Conductivity (field and lab)

SOIL GAS

On and Off-site, in-situ	Minimum 60 measurements	Photoionization Detector
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\*Actual number of samples collected will depend on the number of borings completed and the extent of the soil contamination based on soil gas analysis, instrument readings, and visual inspection.

\*\*This includes background samples but does not include QA/QC samples for liquids: Trip blank per trip, 1 field blank per 20 samples, 1 duplicate per 10 samples. Since the number of trips is unknown

\*\*\*Both filtered and unfiltered samples for metals will be taken.

+Will be analyzed only in first round if not identified.

\*\*\*\*Full HSL scan refers to VDA, BNA, Pesticides, PCB's Metals & Cyanide.

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### 3.1.2 Scope

A well inventory will be conducted of homes within a half-mile radius of the site. Figure 3-1 is a sample well inventory form that will be accompanied by a cover letter. Twenty-five homes will be chosen for sampling. The decision on which wells will be sampled will consider the following factors: 1) Response and completeness of questionnaire, 2) willingness to cooperate, 3) accessibility of well cap, 4) depth of well, 5) well yield, 6) location in regards to potential pollution sources, 7) location in regards to existing data, and 8) location in respect to nearest proposed sampling well. The purpose of the well locationing is to 1) determine the extent of groundwater contamination, 2) locate the source of contamination, and 3) observe fluctuations in concentration overtime since the last measurements were made. Once the preliminary sites are chosen, they will be submitted along with a narrative describing the reason for the choice to the EPA for approval. Parameters for analysis include:

- o Volatile organics (VOAs)
- o Pesticides
- o PCBs
- o Total metals
- o Temperature, pH, conductivity (field)
- o Alkalinity
- o TOC

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FIGURE 3-1

RESIDENTIAL WELL QUESTIONNAIRE

In order to provide us with information important to our study of the groundwater in your area, please complete the following questionnaire. Even if you are not aware of some or all of the details requested, we would appreciate you returning the form. Should you have more than one well, even if it is not in use, please describe it also. Thank you.

Name: \_\_\_\_\_

Address: \_\_\_\_\_

Phone No.: Home ( ) \_\_\_\_\_ Work ( ) \_\_\_\_\_

Are you the original home owner? \_\_\_\_\_ If no, what is the name of the original home owner? \_\_\_\_\_

Well Design:

Total Depth: _____	Pump Depth: _____	Pump Eleva- tion: _____
Casing Material: _____	Pump Size: _____	Screen Type: _____
Casing Depth: _____	Pump Type (submersible/ jet/hand pump): _____	Screen Length: _____
Casing Diameter: _____	Pump Operation: _____	Depth to Ground water: _____
Hole Diameter: _____	(hours per day): _____	
Yield (gallons per minute): _____	Date Well Drilled: _____	
Type of home plumbing: _____	Well Driller: _____	

Water Problems:

Have you ever experienced water quality problems? \_\_\_\_\_ If yes, please indicate when. \_\_\_\_\_

Odor: \_\_\_\_\_ Taste: \_\_\_\_\_ Other: \_\_\_\_\_

Color: \_\_\_\_\_ Hardness: \_\_\_\_\_

Has your water ever been tested? \_\_\_\_\_ If yes, please give date, location, and nature of sampling \_\_\_\_\_.

Do you treat your water? \_\_\_\_\_ If yes, how and why? \_\_\_\_\_

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FIGURE 3-1

(continued)

Have you experienced problems with low water yield or pressure? \_\_\_\_  
If yes, please indicate when. \_\_\_\_\_

Is your well casing easily accessible? \_\_\_\_ If yes, please indicate where. \_\_\_\_\_

Have you ever observed any dumping of liquids in the area that could possibly pollute the subsurface? \_\_\_\_ If yes, by whom, when and where? \_\_\_\_\_

Would you be agreeable to allowing us to collect a water sample and/or measure your water level? \_\_\_\_\_

Would you be agreeable to allowing us to conduct a soil vapor probe analysis? \_\_\_\_\_

Should you have any questions regarding this questionnaire feel free to call us collect at (215) 643-5466.

Please fold this pre-addressed stamped form and mail promptly. Thank you very much for your assistance.

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All parameters will be analyzed under normal CLP procedures. (Refer to Section 3.12 for more detail.) Five the homes will be sampled for full HSL parameters and will be analyzed under normal CLP procedures. Samples will be collected after 20 minutes of purging.

### 3.1.3 Protocol

The following procedure will be used to collect samples from existing residential water supplies. The primary objective of this technique is to collect a sample representative of the ground water supply and not water standing in the delivery system or well casing.

In most cases, ground water samples from existing residential water supplies will be obtained from taps or spigots on the existing delivery system. Samples will be collected from the tap as close to the well as practical and upstream of any filtration or water treatment device.

Operational steps required to obtain a representative sample are as follows:

- (1) Arrangements will be made in advance with the selected residents/businesses for permission and a convenient sampling time.
- (2) Prior to sampling, aerators or filters should be removed from the sampling tap or spigot.

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- (3) If the spigot is located outdoors, attach a garden hose to the spigot so that purge water drains away from the foundation of the house. Disconnect the garden hose prior to sampling.
- (4) Turn tap on, measure rate of flow and pH-conductivity after three minutes.
- (5) After 20 minutes of purging, collect sufficient water for all parameters as indicated in Table 3-2. Unless turbidity is noted in the well, only collect an unfiltered sample for total metals. Because monitor wells are not continually used and flushed clean and they are the only wells which so far have experienced high metals which are probably from clays, they will be filtered as well as unfiltered for metals. Measure temperature, pH and specific conductivity.
- (6) Shut off tap and restore system to previous arrangement.
- (7) A duplicate sample will be collected from two locations out of the 25. The duplicate locations will be chosen ahead of the field trip to attempt to collect a duplicate from a known contaminated and a background well. Since no sampling equipment will be used to contaminate the sample, no blank sample will be collected. A trip sample will be collected to monitor shipping cleanliness.

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(8) In addition to information normally recorded in field notebook, the following information should be included (if possible):

- resident's name
- address
- sampling location (specific tap or spigot)
- filtering or treatment systems on delivery system
- aerator or filter on sampling tap
- well casing diameter (ID)
- water level
- well volume
- pressure and holding tank volume
- appurtenances and other plumbing volume
- total delivery system volume
- purge flow rate
- purge time
- total purge volume
- septic tank location (with respect to well location)
- use of septic tank cleaners

#### 3.1.4 Equipment

- o Field log book
- o Sample containers, labels, log sheets, cooler

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- o pH meter, thermometer and specific conductivity meter
- o DI water
- o Graduated volume container
- o CLP Documentation (sample tags, custody seals, traffic reports, chain-of-custody forms)
- o Hose

### 3.2 Soil Gas Analysis

#### 3.2.1 Objective

Soil gas analysis will be performed to identify possible areas of soil contamination so that sampling can be performed to determine the levels and extent of the contamination. In addition, the soil gas analysis will enable the user to better locate monitor wells in areas of possible contamination. The limitations of soil vapor sampling cause it to be used as a supportive technique and not a true screening method. Thus, areas where the probe does not reveal organic vapors does not imply that the deeper zones beyond the reach or sensitivity of the probe will not be further evaluated.

#### 3.2.2 Scope

Soil gas readings will be initiated in areas where the presence of volatile organic compounds (VOCs) is most strongly suspected. These areas

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will be defined through prior field evidence of reported spills, stained soil and contaminated groundwater. The proposed sites will be submitted to EPA two weeks prior to sampling for their approval. A minimum of 60 readings are expected. The placement of additional sampling points will depend on the previous readings. The readings will be mapped and analyzed for use in soil sampling and monitor well locations. Off-site readings may be taken if previous readings indicate the presence of soil contamination off-site. Generally, the suspect area will be surveyed in a 10 foot grid pattern. Field results will dictate whether the grid will be expanded in a preferential direction to focus on a suspect spill site.

The slam bar method will be used, at EPA's request, during the investigation. The slam bar technique refers to a system manufactured by K-V Associates which consists of hollow steel tubes driven or "slammed" by a weight into the ground to allow withdrawal of a soil vapor for analysis. This procedure involves hand driving a bar with a hollow core 3' to 5' into the ground. After removal of the sample, the gas in the void is extracted for analysis. Volatile organic compounds will be analyzed using a field PID.

### 3.2.3 Protocols

- (1) Measure and document background ambient air quality using air samples collected on site from four opposing locations. The speed and direction of air movement will be recorded.

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- (2) Calibrate the analytical system (PID) upon equipment set up and after the analysis of every 10 samples. Calibration will follow the manufacturer's recommended procedures.
- (3) Establish sampling locations.
- (4) Utilizing "slam bar" methodology, drive the soil gas probe into the soil to a depth of between three (3) and five (5) feet below the surface.
- (5) Insert teflon or stainless steel tubing into the soil probe and seal off the top of the soil probe.
- (6) Connect the vacuum pump. Pump three times the calculated volume of air contained in the tubing and probe by noting and recording the rate of air flow through the pump. Purging rate will be dictated by the permeability of the soil in relation to the pump strength.
- (7) Utilize a bulb or syringe to collect a volume of soil gas with the aid of a vacuum pump.
- (8) Measure VOCs in the volume of collected gas at the mobile lab on-site through a photo ionization detector (Photovac T.I.P. or equivalent). Record all calibration and spike data as well as analysis results.

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- (9) Collect and analyze duplicate samples at every third location to assure data reproducibility. Run matrix spike duplicate at beginning and end of each day of use.
- (10) Data from soil gas sampling will be mapped and integrated with the soil sampling analysis results to better define the potential contaminant source location.

#### 3.2.4 Equipment

- o Slam bar (KV & Assoc. Soil Vapor Probe)
- o Soil gas probes (galvanized pipe)
- o Drive points
- o Vacuum pump
- o Air flow meter
- o Assorted gas tight fittings for connection to GC
- o Teflon tape
- o Photoionization Detector with 11.5 e.v. lamp
- o Decontamination equipment
- o Photoionization detector
- o Stakes, flagging, markers
- o Site map

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### 3.3 Surface Soil Sampling

#### 3.3.1 Objective

Surface soils will be sampled and analyzed for chemical contaminants as listed in Table 3-2 under Field Surface Soils, to determine the locations of contaminant sources and define their composition. This will aid in developing a remedial program, if necessary.

#### 3.3.2 Scope

Approximately 25 suspect sites will be sampled and analyzed. The locations will be determined employing information gained from soil probes, aerial photographs and field observations. The proposed sampling locations will be submitted to EPA for approval two weeks prior to sampling. Head space sampling will be done in the field as well as the laboratory to ensure that vapors are not lost from the soil during transport and to field screen sites. The soil will be analyzed for the following:

- VOA (HSL)
- Pesticides
- PCB's
- Metals (1 full HSL scan and analysis, second sample for HSL parameters if found present)

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### 3.3.3 Protocol

- (1) Using a clean stainless steel trowel or bucket auger dig down 6 inches.
- (2) Collect a sample from 6 to 12 inches for head space analysis.  
The sample used for head space analysis will not be the sample submitted to the laboratory for analysis.
- (3) Shake the closed sample jar, wait one minute and take a head space reading with a HNu or OVA. The detectors will be field calibrated on a daily basis prior to their use.
- (4) Collect a sample for laboratory analysis into two 120 ml glass vials, followed by two 8 oz. glass jars and store in coolers.
- (5) Record the following: date, time, sampler's name, sample number, location, depth, interval, color, texture, moisture content, and FID/PID reading/calibration data.
- (6) Label jars, stake location, and document on site map.

### 3.3.4 Equipment

- o HNu and/or OVA
- o Sample containers (refer to Section 3.12.3)
- o Stainless steel trowels or augers
- o Labels and marker

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- o CLP sample documentation
- o Stakes and flagging
- o Decontamination equipment
- o Packaging equipment

### 3.4 Surface Water and Spring Discharge Sampling

#### 3.4.1 Objective

This sampling will be conducted to determine if contaminants are migrating on or off the site with surface or spring discharge runoffs.

#### 3.4.2 Scope

Collect a total of 12 samples, 10 to be located within a 1,000 area of the CryoChem building and two to be located out of the site area.

Parameters include:

- o VOAs (HSL)
- o Pesticides
- o PCBs
- o Total metals (2 of 12 full HSL scans)
- o Conductivity, ph (field and lab), temperature (field)
- o Hardness
- o Dissolved oxygen
- o Total dissolved solids

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- o Suspended sediments
- o Total organic carbon
- o Alkalinity

Two (2) of the 12 samples will be analyzed for full HSL parameters; one on-site and the other off-site. All samples will be analyzed under normal CLP procedures. The proposed locations of the sampling points will be submitted to EPA for approval and notice of the sampling date provided at least two weeks prior to sample collection.

#### 3.4.3 Protocol

- (1) Collect samples, starting with downstream locations finishing with the most upstream location. The sampling site shall be in the center of the stream at a depth 70 percent above the stream base to ensure a consistent mixing zone.
- (2) Fill appropriate sample bottles making sure not to disturb sediments. A clean bottle, dedicated to each sample, will be used to take water out of the stream. No labels or marking pens/paint etc. will be on the outside of the bottle.
- (3) Field filter sample for dissolved metals analysis as outlined in Section 3.12.

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- (4) Record time, location, sample number, pH, temperature, and specific conductivity, stream flow depth of water and visual feature.
- (5) Stake and flag the sampling point and locate it on the map. A stake will be placed on each side of the stream and labeled. The sampling location in the stream will be in reference to the two stakes. The location of the stakes will be measured in reference to a permanent feature.
- (6) Preserve samples after collection as outlined in Table 3-3.

#### 3.4.4 Equipment

- o Log book and map
- o Sample collection and storage containers, packaging, and appropriate preservatives
- o pH meter, conductivity meter, thermometer
- o Waterproof markers
- o CLP documentation
- o Field Filter
- o Hip boots

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### 3.5 Stream Sediment Sampling

#### 3.5.1 Objective

Sediment samples will be collected to confirm earlier on-site stream sediment sample results and to determine the extent of downstream sediment contamination.

#### 3.5.2 Scope

Collect 6 samples both on-site and off-site. The two off-site sample points will be chosen in the field and will correspond to the two off-site surface water samples. The locations of all sampling sites will be chosen as prior information becomes available. The proposed locations will be submitted to EPA for approval and they will be notified two weeks in advance of sampling. The locations will be chosen based upon confirmation of background and downsite stream quality. Parameters to be tested for include:

- o VOAs (HSL)
- o Pesticides
- o PCBs
- o Total Metals

Two samples will be analyzed for full HSL parameters; one on-site the other off-site. Sediment sampling locations will correspond to surface water locations. All samples will be analyzed under normal CLP procedures.

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### 3.5.3 Protocol

- (1) Collect samples (0-6 inches) with clean stainless steel trowel after surface water samples are collected. Downstream sediment samples will be collected first and sampling will continue upstream. At locations where both surface water and sediment samples are collected, surface water samples will be collected first.
- (2) Fill sample jars using a trowel or clean wide mouth jar dedicated to each sample which will not contain labels or tape that could contaminate the sample. Sediment shall be collected from the finest grain size, ideally clays to a depth of four inches. Organic matter will be avoided. The excess water collected with the sediments will be put into the sample jar but will be kept to a minimum by displacing it with as much sediment as possible.
- (3) Record: date, time, sampler's name, location, sample number, color, and sample consistency.
- (4) Flag, stake and locate the sample point on the map.

### 3.5.4 Equipment

- o Log book and map
- o Sample containers, packaging and labels

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- o HNu and/or OVA
- o Stainless steel trowels
- o Water proof marker
- o Decontamination equipment
- o CLP documentation

### 3.6 Ground Water Sampling

#### 3.6.1 Objective

Ground water sampling will be conducted to verify, update and expand on prior sampling results; to further characterize area hydrology and ground water quality; and to locate possible contaminant migration pathways.

#### 3.6.2 Scope

Collect samples from the two monitor wells on-site; the production well and up to 11 newly installed monitor wells. A second set of similar sampling will be performed between one to four months later to confirm analysis results and note possible fluctuations over time. Parameters include:

- o VOAs (HSL)
- o Pesticides+
- o PCBs+
- o Soluble and total metals (3 HSL Scans)
- o Temperature, pH and conductivity (field & lab)
- o Alkalinity
- o TOC

+ Will be analyzed only on first round if not found

The production well, one bedrock well and one shallow (soil profile) well will be sampled and analyzed for full VOA and metal HSL parameters. All samples will be analyzed under normal CLP procedures.

### 3.6.3 Protocol

Wells will be sampled in an order corresponding from those suspected to be the least contaminated to those suspected to be the most contaminated. Determination of this order is contingent upon the previous groundwater analyses, water level contour map showing flow direction and soil studies.

- (1) Unlock the well and take an OVA/HNu reading to determine the appropriate level of safety.

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- (2) Measure and record the depth of the well from the top of the inner casing; note any deviations from the depth as installed; record the height of the protective casing; record the differential between the protective casing and the top of the interior well casing to ensure that changes in the casing height have not been made.
- (3) Measure and record the depth to water using a "M-scope" type device measured to the nearest 0.01 foot and rinsed between wells; record the data in the log book or on a sampling sheet.
- (4) Subtract the depth to water from the measured depth of the well.
- (5) Calculate and record the volume of water in the well.
- (6) Lower a clean pump with housing and dedicated polyethylene safety rope 5 feet into the water column and turn the pump on. Lower the pump as the water level drops.
- (7) Remove three (3) well volumes unless well immediately pumps dry (1 volume). In this case, the well will be sampled after seventy-five percent (75%) recovery or within 2 hours, whichever occurs first (sample volume permitting). Record purged volume, pH-conductivity at 5 minute intervals and recovery rate.  
Containerize the water removed during pumping.

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- (8) Allow the well to recharge and gently lower a clean bailer (stainless steel or teflon) with polyethylene rope into the water. Samples should be collected from the middle of the screened area of the well. Collect samples in the following sequence:
- Volatiles
  - Semi-volatiles (for 3 of 14 samples)
  - Pesticides+
  - PCB's+
  - Metals (unfiltered (total) then filtered (soluble) when necessary
- +Will be analyzed only in the first of two rounds if not identified.
- (9) Record the pH, specific conductivity, temperature and depth of water at time of sampling.
- (10) Filter the soluble metals sample as soon as possible after collection. Preserve the samples accordingly. SOPs for filtration and preservation are outlined in Section 3-12.
- (11) Store the purged water in individually labeled storage tanks in the CryoChem site. Contingent upon the results of the laboratory analysis, they will either be emptied immediately if the

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water is found to be clear or treated on-site by aeration etc.  
if it is found to be contaminated and/or properly disposed of.

(12) Relock well and decontaminate (Table 3-1) equipment for next well.

#### 3.6.4 Equipment

- o Well key
- o Water level probe
- o Folding rule
- o Field notebook
- o Submersible pump, dedicated discharge hose, and safety line
- o Bailer and polyethylene rope
- o Specific conductance, pH, temperature meter(s)
- o HNu and/or OVA
- o Dedicated filtering apparatus
- o Sample containers, labels and preservatives
- o Waterproof markers
- o CLP documentation

### 3.7 Soil Borings and Shallow Well Installation

#### 3.7.1 Objective

This task will be conducted to accomplish the following objectives:

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- o To characterize the nature and extent of potential soil contamination.
- o To ascertain if the soil water is or is not part of the same water bearing zone identified in bedrock wells.
- o To investigate contaminant migration both vertically and horizontally.
- o To investigate any possible concentration of contaminants in the zone of transition between the overburden and bedrock (see Section 1.7).

### 3.7.2 Scope

Drill, log and sample six (6) soil borings to characterize contaminant sources, site stratigraphy, and hydrogeology of the overburden. The borings will be continuously sampled either with five foot sections using continuous barrel samplers (inside the auger) or by continuous two foot split-spoons. These samples of the soil core obtained from the split spoon sampler will be screened by taking head space readings, using photoionization detection to identify zones containing the target volatile organics which can then be collected specifically for laboratory analysis, (as outlined in Subsection 3.2.3 step (7)), by making visual observations (e.g., staining), and by noting stratigraphic conditions to collect perched

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liquids sitting on an impermeable layer, (changes in lithology) to determine if the sample will be sent to the laboratory for analysis. The split spoon core, when opened, will immediately be measured using a photoionization detector. To prevent the loss of volatiles, any soil which registers a reading will be contained for lab analysis. Any soil core which does not reveal a vapor in the preliminary survey will be sliced in half, rescanned then one foot intervals placed in jars for headspace analysis. In addition to the above screening criteria, two (2) samples will be collected and analyzed, one from the 0-5 foot interval and one from just above bedrock refusal. After soil sampling, these borings will be cased into competent bedrock by drilling five feet into competent bedrock, by attaching a drive shoe to the casing, seating the casing in the hole and pouring grout into the annulus via the tremie pipe method. These cased holes will later be used in construction of bedrock monitor wells (see Subsection 3.8). If water is encountered in the overburden, shallow wells will be installed (see Subsection 3.7.3 step (8)).

If soil gas analysis from soil probes and/or monitor well testing reveals a substantial area (beyond what can accurately be delineated) of soil contamination up to five (5) additional soil borings will be drilled in areas to be approved by EPA, and sampled every 5 feet for VOA using the PID vapor meter. If organic vapors are encountered the samples will be analyzed for the full range of parameters shown below. No wells will be installed in these extra borings.

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From twelve (12) to fifty (50) samples will be analyzed. Parameters include:

- o VOAs (HSL)
- o Pesticides
- o PCBs
- o Total Metals

The deepest sample collected from each boring (up to 11) will be analyzed for full HSL parameters. All samples will be analyzed under normal CLP procedures.

Approximately 22 soil samples will be collected for analysis in the laboratory of:

- o Soil particle size
- o Organic carbon
- o Bulk density
- o Moisture
- o Permeability
- o OSCS classification

### 3.7.3 Protocol

The soil borings will be drilled using hollow stem augers. Continuous samples will be collected from the surface to bedrock refusal.

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If obstructions which hinder sample collection are encountered, grout the hole and move the boring to a nearby (5 feet away) location. During drilling operations continuous-air monitoring will be done and appropriate levels of safety protection will be followed (as outlined in the HASP).

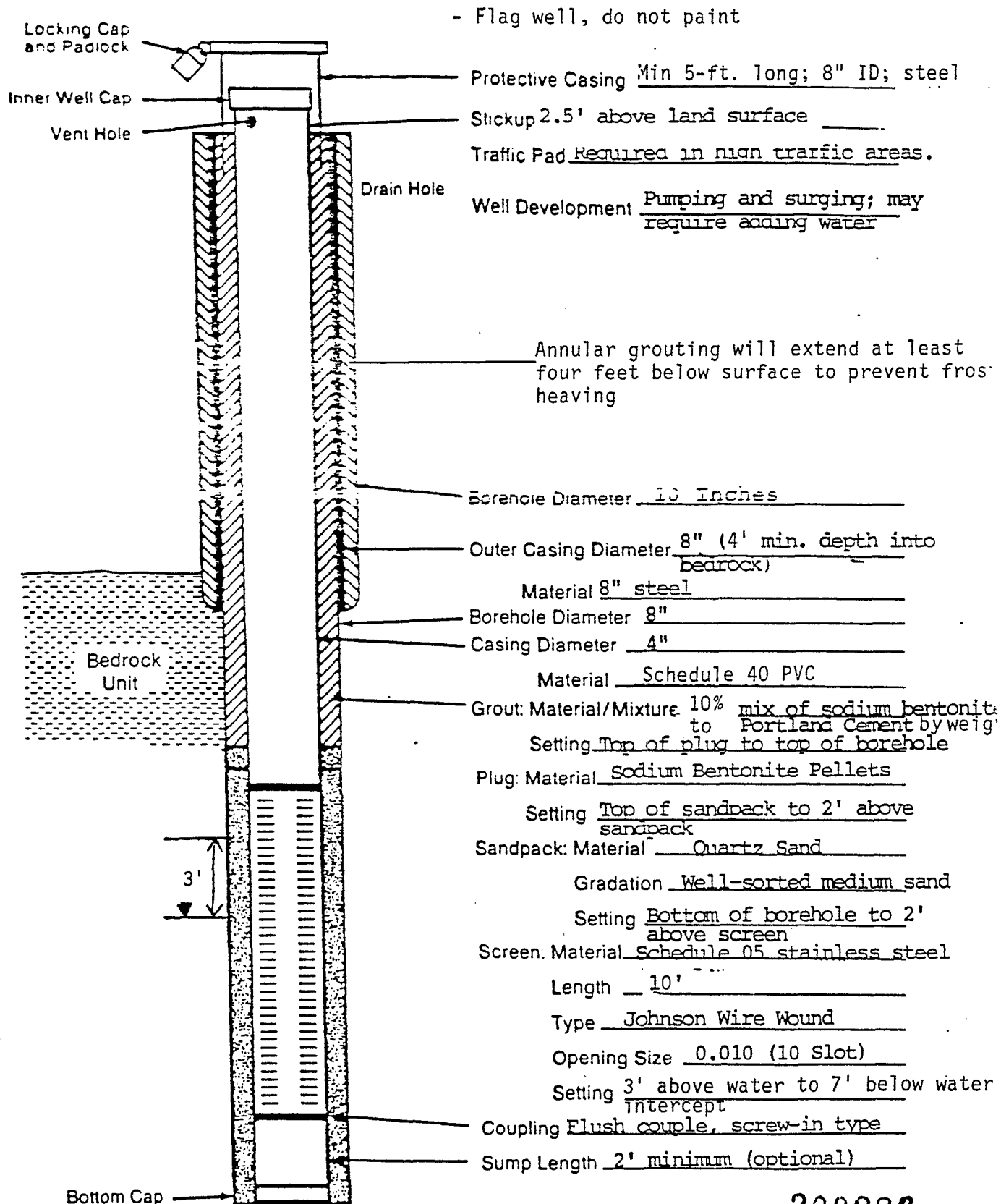
The following is an outline for sample collection and data recordings:

- (1) Place the sample barrel on a clean plastic sheet and use an HNu to detect any volatile organics.
- (2) Take a head space reading as outlined in Section 3.2.3, step 3.
- (3) Record a description of the sample in the field log, including:
  - o Sample interval;
  - o Downhole air monitoring measurements as well as HNu readings as the sample barrel is retrieved;
  - o Grain size and texture (e.g., fine sand, silty clay);
  - o Color based on visual inspection;
  - o Moisture content (i.e., dry, moist, wet);
  - o Other detailed observations (staining of soil, driller's comments, construction rubble containing bricks, tires, broken bottles).
- (4) Obtain representative samples of each type of lithology for a permanent stratigraphic record.

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- (5) Collect sample using a clean stainless steel spatula. Divide the sample from each spoon equally between sample jars. Clean spatula between samples.
- (6) Record all information and label sample jars.
- (7) Collect 22 grain size samples from various significant lithologies that are representative of permeable and impermeable layers. Approximately one cubic foot of material will be collected for each sample. Samples will be stored in sealed dark plastic bags and labeled. A chain of custody form will accompany all samples. Additional samples not used for analysis will be logged and stored in a frost free area.
- (8) If boring is to be converted to a bedrock well, install casing according to specifications outlined in Figure 3-2. If boring is not to be converted to a well, grout the hole to the ground surface using tremie methods.
- (9) If water is found in the soil profile off-set and install shallow wells near bedrock well locations as outlined in Figure 3-3.

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FIGURE 3-2 SUMMARY OF SPECIFICATIONS FOR SCREENED BEDROCK MONITOR WELL COMPLETION.

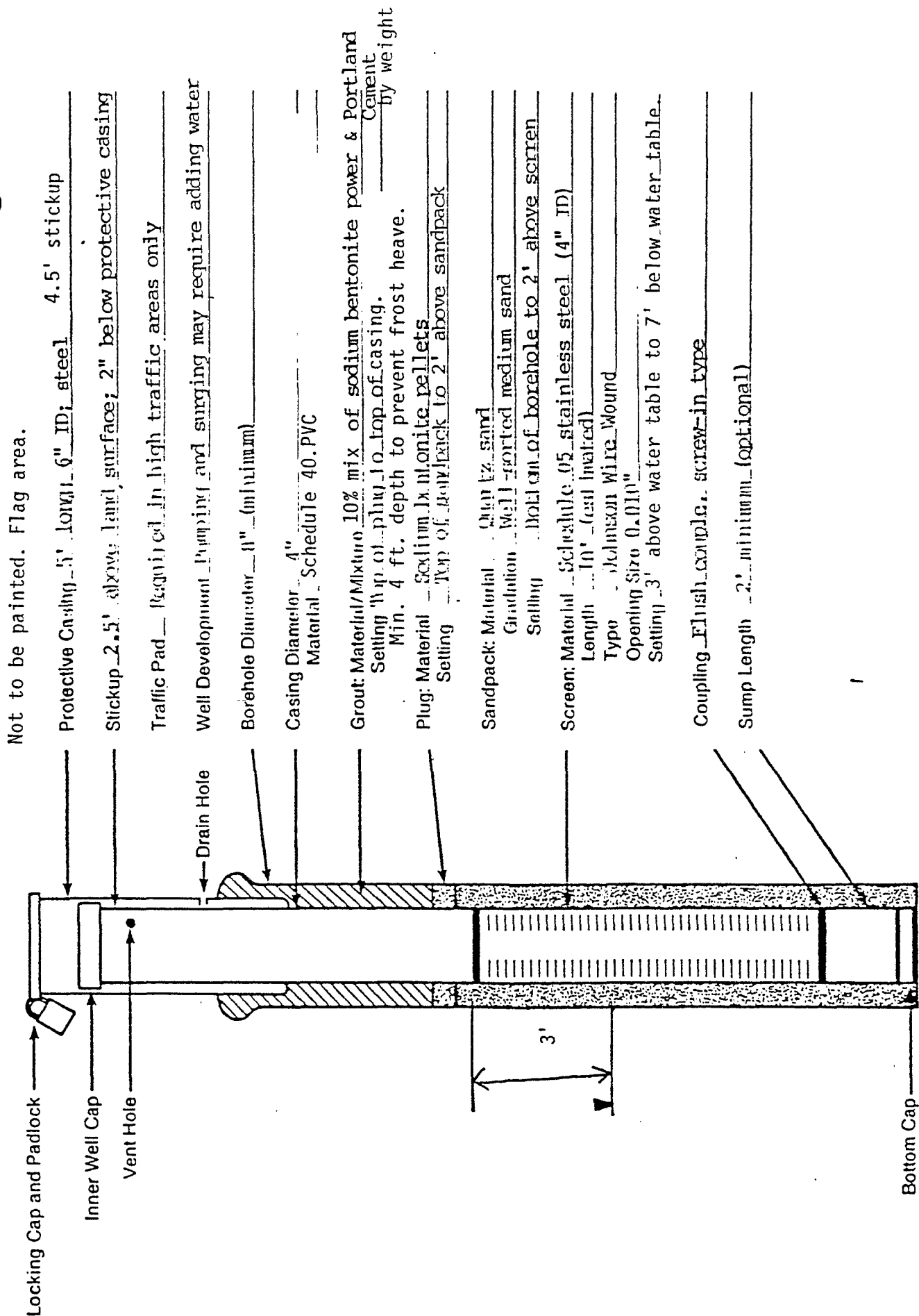


FIGURE 3-3 SUMMARY OF SPECIFICATIONS FOR SHALLOW MONITOR WELL COMPLETION

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- (9) Gravel pack, and bentonite seal the well using downhole placement methods specifically a tremie pipe inserted to the depth of application and withdrawn as the material flows into the annulus. Grout the well to the ground surface using tremie methods and a 10 percent bentonite to 90 percent portland cement by weight mix.
- (10) Well development will take place twenty four (24) hours (or more) after well completion. Well development will consist of pumping by surging until water runs clear. The pumping will be accomplished by either blowing air from the well using the on-site air or by installing a portable pump to flush it out. Water will only be added in extreme situations where inadequate well recharge is occurring. Discontinue pumping after two (2) hours if the water is still turbid and note the appearance of the water. The water will be drummed and stored on-site. It will be tested and disposed of in an approved manner, after consultation with EPA.

#### 3.7.4 Equipment

- o A drill rig capable of obtaining continuous barrel (five foot) samples.
- o Five (5) or more two-foot long split spoon barrels.
- o Log book
- o HNu and/or OVA

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- o Sample containers (chemical and stratigraphic)
- o Decontamination equipment
- o Stainless steel sampling spoons or trowels
- o CLP documentation

### 3.8 Bedrock Monitor Well Installation

#### 3.8.1 Objective

Bedrock monitoring wells will be installed to characterize the nature of the aquifers; to evaluate the extent and levels of contamination on-site; and to further define contaminant migration pathways.

#### 3.8.2 Scope

Drill, log, install and in one of the instances, core five (5) bedrock monitor wells to characterize stratigraphy, fracture zones and hydrogeology of the bedrock under the site. The bedrock wells will be constructed in the casings previously installed during soil borings (see Subsection 3.7). One of the wells will be continuously cored from top of bedrock for stratigraphic and fracture characteristics. The remaining wells will be drilled using air rotary methods and then logged with temperature, caliper and borehole camera. Wells will be drilled to the first zone of sufficient yield of water for monitoring determined by monitoring the well drilling returns and defined as a flow of more than 0.5 gpm. Ten feet of screening will be installed only if the structure of the bedrock is

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incompetent to remain open unscreened. Specifications for bedrock wells are presented in Figure 3-2 and Figure 3-4.

### 3.8.3 Protocol

The wells will be drilled in the cased off soil borings using air rotary methods. Core samples or drill cuttings will be used to log the holes. During drilling operations continuous air monitoring and appropriate levels of safety protection will be followed (as outlined in the HASP). The following is an outline for drill operations:

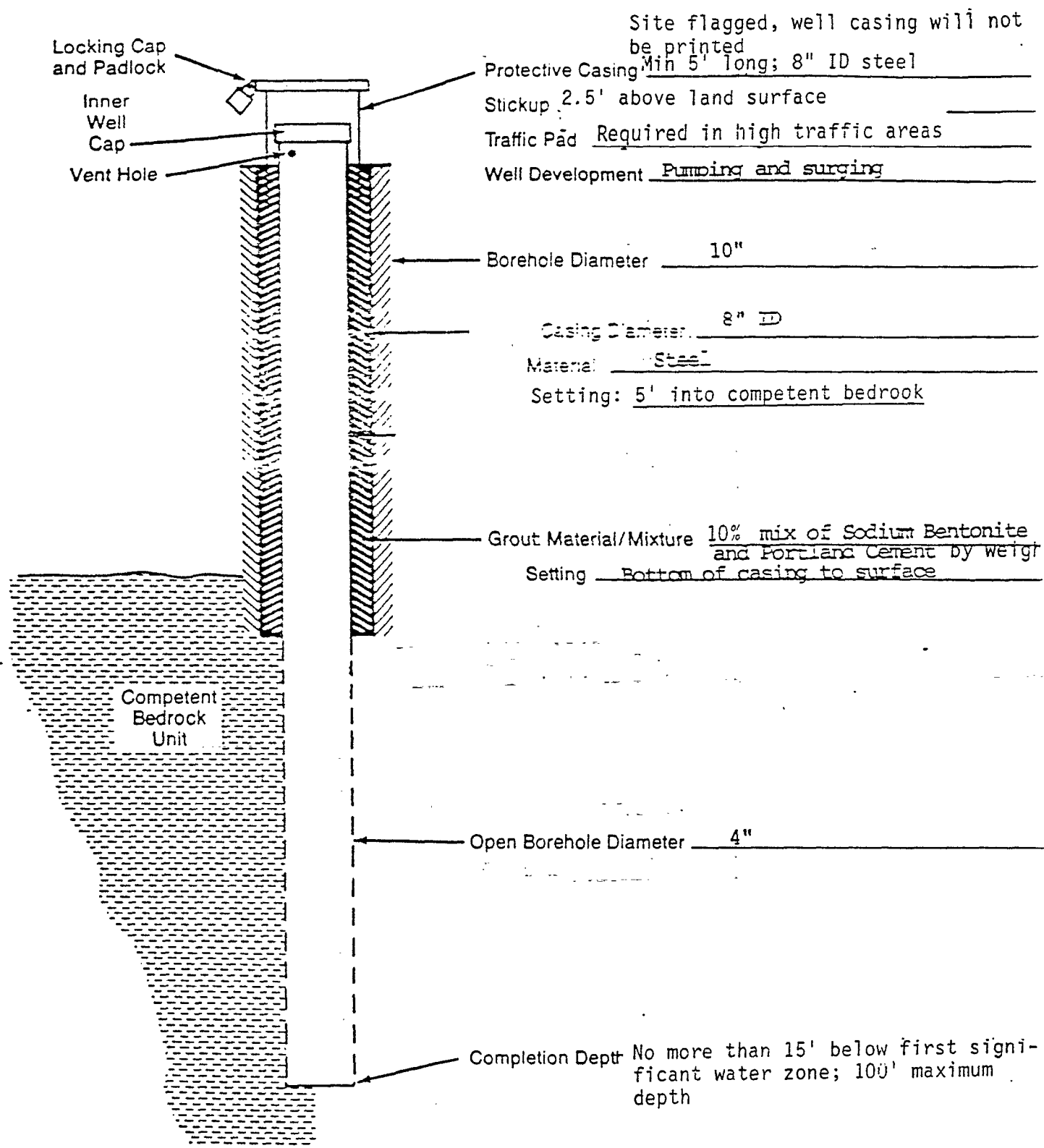
(1) Record:

- o drilling speed (time intervals/footage drilled)
- o loss of pressure
- o depth to bedrock
- o descriptions of cuttings and/or core samples
- o drillers comments
- o any breakdown or problems (time, problem)
- o all water encountered; flow rate (estimate)

(2) When the drilling and coring is finished, a decision will be made to screen and case the well (see Figure 3-2) or to leave an open borehold with outer casing set five feet into bedrock (see Figure 3-4).

(3) Well is developed as outlined in Subsection 3.7.3, step 10.

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FIGURE 3-4

**SUMMARY OF SPECIFICATIONS FOR  
OPEN HOLE BEDROCK MONITOR WELL CONSTRUCTION**



#### 3.8.4 Equipment

- o An air rotary drill rig
- o Three (3) 5-foot core barrel samplers
- o Log book
- o HNu and/or OVA
- o Stratigraphic sample containers and core boxes
- o Decontamination equipment

#### 3.9 Well Testing

##### 3.9.1 Slug Tests

###### 3.9.1.1 Objective

Slug tests will be conducted to estimate the magnitude and variability of selected aquifer properties in the water bearing zone.

###### 3.9.1.2 Scope

Conduct slug tests on a minimum of four selected monitor wells having significantly varying yields and/or geology. The choice of wells will be approved by the EPA prior to the test. The tests consists of causing an instantaneous change in water level in a well or piezometer and observing the recovery level in the well with time.

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#### 3.9.1.3 Protocol

- (1) Test wells in an upgradient to downgradient sequence to be determined by initial water level data.
- (2) Examine the well to be tested to determine the condition of the well seal, locking cap, and casing. Document any problems.
- (3) Open the well, measure and record the air using a photoionization detector and measure the depth to water.
- (4) Protect the transducer cable by taping the well casing with duct tape to cover the top edge.
- (5) Clean the transducer by sequentially rinsing the probe and attached line with tap water, Alconox in tap water, and distilled water.
- (6) Lower the transducer into the well to a depth of at least fifteen (15) feet below the top of the current water level and secure it with duct tape in that position.
- (7) Connect the data logger to the transducer to determine the height of the water column above the transducer and confirm water level using an M-scope.
- (8) Wait for a period of five (5) minutes before continuing the test to allow the well water level to re-equilibrate.

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- (9) Lower a previously prepared slug (2.5-inch diameter PVC pipe a minimum of 10 feet in length for a 4-inch well) tied to a suitable hauling line, into the well to a point just above the water level.
- (10) Activate the data logger and run for about one (1) second. While the data logger is functioning, rapidly but smoothly lower the slug into the water in the well to just below the initially recorded water level.
- (11) Secure the slug in this position, and continue to test for an appropriate time period anticipated to be no more than 60 minutes. May be longer in silty-clayey soil and fractured rock.
- (12) After the test period has elapsed, but before the data logger is stopped, make a copy of the data readings on the field printer. Examine the data to determine whether the water level has reestablished equilibrium. Equilibrium is defined as four consecutive readings that are equal, within the permissible variance value for the selected transducer.
- (13) Extend the test for 10 additional minutes if the well has not reestablished equilibrium. Repeat this procedure for up to one hour if necessary.

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- (14) When water level equilibrium has been reestablished, step the data logger to the next setting to record the next phase of the slug test.
- (15) Untie the slug hauling line from its surface attachment, and activate the data logger for a period of one (1) second.
- (16) Lift the slug upward above the water surface smoothly and quickly (but do not remove it from the well) and secure it to the well casing. Run the test as described in Items (10) - (14).
- (17) Make a complete copy of the data and remove and clean the test apparatus from the well using a nitric acid and acetone wipe as outlined in Table 3-1. Move to the next site, following steps 1 through 17.
- (18) Transfer data stored in the data logger to a computer after all slug tests are completed and analyze data using the Hvorslev method.

#### 3.9.1.4 Equipment

- o Automated continuous recording data logger and accessories;
- o Water level probe;
- o 2.5-inch diameter slug and replaceable line;

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- o Decontamination supplies;
- o Log book.

### 3.9.2 Packer Tests

#### 3.9.2.1 Objective

Packer tests will be conducted to estimate the magnitude and variability of selected aquifer properties in the bedrock wells.

#### 3.9.2.2 Scope

Up to five bedrock wells will be packer tested using a falling head technique. The decision to perform packer tests will be made based on the nature of the fractures in the core samples. A packer test will only be performed if a discrete set of fractures are encountered, and if the presence of vertical fractures in the side of the borehold does not preclude proper packing off of the section of the borehold to be tested.

#### 3.9.2.3 Protocol

- (1) Determine from the rock core if a packer test should be performed. For those wells not cored, determine if there are unique features (fractures, solution cavities, aquitards etc.) that were not found in the cored hole or are in an important location that should be tested.

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- (2) Measure the depth to the discrete fracture zone.
- (3) Set the lower packer below and the upper packer above the fracture zone.
- (4) Inflate the packers.
- (5) Place the pressure transducer down the stem leading into the packer and calibrate.
- (6) Fill the tube with clean water (from an approved source) to the top and record the change in water levels in the tube over time.
- (7) Analyze the data collected.

#### 3.9.2.4 Equipment

- o Packers and accessories
- o Drill rig
- o Automated continuous water level recorder and accessories
- o Approved water source
- o Water level probe
- o Decontamination supplies
- o Log book

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### 3.9.3 Aquifer Testing

#### 3.9.3.1 Objective

The objective of an aquifer test is to determine the characteristics of the aquifer under stressed (pumping) conditions. Measurements collected will help determine the cone of depression caused by pumping and the aquifers transmissivity and storage capacity. This information will be useful to determine possible contaminant and water movement through the aquifer.

#### 3.9.3.2 Scope

Following analysis of a slug and packer tests an aquifer tests will be designed and performed. The aquifer test (48 hour minimum) will be accomplished by using the production well on-site or a new monitor well. A step drawdown test on the pumping well may have to be done before the actual aquifer test is started. It involved pumping the well at different flow rates to determine the ideal pumping rate for the aquifer test. The pumping well will be pumped at a constant rate while the water level changes in the pumping well and observation wells will be recorded.

#### 3.9.3.3 Protocol

- (1) Take pumping well out of service at least 24 hours before test.
- (2) Measure depth to water on the pumping well and all observation wells.

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- (3) Install and calibrate water level transducers in the pumping well and as many of the observation wells as possible. Other wells will be monitored by water level recorders or JACA personnel.
- (4) Connect the transducers to an automatic water level recorder.
- (5) The pump will be turned on and water-level measurements at the pumping and observation wells will be monitored throughout the test.
- (6) The pumping rate will be monitored and recorded throughout the test.
- (7) During the test, time series samples from the pumping well (for VOAs only) will be collected at 1 minute, 15 minutes, 30 minutes, 60 minutes, two hours, 4 hours and every 8 hours after till the end of the test. Care will be taken to "throttle back" the pump so as to minimize vaporization from the impeller blades.
- (8) A decision on the method of disposal of the discharge water will be made prior to the test after analysis and consultation with the EPA.
- (9) At the completion of the test, recovery measurements are recorded in the same manner as the drawdown measurements.

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- (10) These data, head and time in pumping well and observation wells, pump rate, and distance between pumping well and observation wells will be evaluated using a computer program based on methodology presented by Theis (1935), "The Relation Between the Lowering of the Piezometer Surface and the Rate and Duration of Discharge of a Well Using Ground Water Storage," and Cooper and Jacob (1946), "A Generalized Graphical Method for Evaluating Formation Constants and Summarizing Well Field History," and Hantush (1964), "Hydraulics of Wells."

#### 9.3.4 Equipment

- o In-situ automated water level recorder
- o Water level probes
- o High capacity submersible pump and generator (only if a monitor well is to be used as the pumping well)
- o Field Printer
- o Field Book

### 3.10 Continuous Water Level Monitoring and Sampling

#### 3.10.1 Objective

The objective of this task is to gather data on the effects of precipitation and on- and off-site pumping on water and contaminant levels over time.

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### 3.10.2 Scope

During the field investigation, information will be gathered on production well use (times, estimated use). After monitor well installation, continuous water level recorders will be installed on two selected wells on-site. Well selection will be dependent upon the results of the production well pump test and shall be approved by the EPA. The chart paper on the records will be changed monthly. At the same time the stream levels and flow will be measured at the upstream crossing of Rt. 562 by installing a stream staff gauge correlated to flume measurements. The production well will be sampled (VOA only, CLP) monthly to correlate contaminant levels with cone of influence size. Precipitation data will be gathered and correlated to water levels and contaminant levels. Monitoring will occur for three to four months.

### 3.10.3 Protocol

- (1) Install continuous water level recorders on selected wells.
- (2) Change chart paper monthly.
- (3) Measure surface water levels monthly.
- (4) Sample production well monthly.
- (5) Correlate results with precipitation and production well use.

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#### 3.10.4 Equipment

- o Stevens water level recorders and accessories
- o Log book, sample containers and labels
- o Water level probe and ruler
- o CLP documentation

#### 3.11 Shop Drain System Testing

##### 3.11.1 Steel Pipe Test

###### 3.11.1.1 Objective

The objective of this task is to test the shop drain system's steel pipe which extends from the shop drain pit to the outside manhole (No. 2) for leakage.

###### 3.11.1.2 Scope

The steel pipe of the shop drain system will be tested by using a standing head test.

###### 3.11.1.3 Protocol

- (1) Calculate holding capacity of pipe.
- (2) Seal lower end of pipe at manhole No. 2.

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- (3) Fill drain with water and note any changes in level over a 2 hour period.
- (4) Calculate loss of water if any.
- (5) Calculate leakage rate under free flow conditions using a simple derivative of Darcy's Law.

#### 3.11.1.4 Equipment

- o Plumbing equipment to plug pipe
- o Log book, ruler, calculator and stopwatch
- o Clean water obtained from a public water supply

#### 3.11.2 Concrete Pipe Test

##### 3.11.2.1 Objective

To test the concrete pipe leading from the shop at manhole No. 2 to the outfall at the stream for leaks.

##### 3.11.2.2 Scope

The scope will involve testing of the pipe under conditions similar to when waste solvent was spilled in the drain.

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3.11.2.3 Protocol

- (1) The surface of the concrete pipe, which is immediately below the surface, will be excavated to note the locations of connections between pipe segments.
- (2) Under dry conditions, soil moisture probe readings will be made adjacent to each connection at a depth of one foot beneath the pipe and the measurements recorded.
- (3) Clean water, from a public water supply, will be poured in manhole No. 2 at a rate of five (5) gallons per minute for one hour.
- (4) Soil moisture readings will be made at the same locations. An increase in soil moisture will be indicative of a leak which shall warrant future excavation of the site to search for contaminated soil.

3.11.2.4 Equipment

- o Soil moisture probe
- o Shovels
- o Log book
- o 300 gallon storage tank filled with clean water
- o Gallon bucket and stopwatch

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### 3.12 Sample Preservation, Filtration, Packaging, and Shipping

#### 3.12.1 Objective

The objective of sample preservation, filtration, packaging, and shipping is to accurately document sample quality and integrity from field collection to laboratory analysis.

#### 3.12.2 Scope

Collected samples must be properly prepared, handled, and shipped with appropriate EPA and DOT documentation. All samples collected at the CryoChem site will be shipped as low-level (environmental) samples and transported by the contractor in road vehicles. All filtering will be done according to step (5) of the protocol. Table 3-3 and 3-4 outline procedures and methods to be used in the shipping and analyses of the samples.

#### 3.12.3 Protocol

- (1) Use bottles prepared by the QC Inc. Laboratory. Record lot numbers for each bottle used.
- (2) Review Table 3-3 regarding required preservation, bottle types, and documentation.
- (3) Wear proper sampling gear (see HASP). Collect samples in the order specified.

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TABLE 3-3  
REQUIRED SAMPLE CONTAINERS, PRESERVATIVES, AND DOCUMENTATION

<u>Sample Type</u>	<u>Level</u>	<u>Required Containers</u>	<u>Fixative</u>	<u>Fill Level</u>	<u>Documentation</u>
Organic (AQ)	Low	2, 40-ml glass vials (VOA) and 4, 1-L amber or 2, ½-gal amber glass bottles (A/B neutral extractables)	Cool, 4° C.  Cool, 4° C.	100%  90%	Sample tags (per container)* + Adhesive Traffic Report labels (per container) Organic and Inorganic Traffic Report (per sample set)** Chain of Custody (per laboratory) Custody Seals (per container) Air bills (per laboratory)
Inorganic (AQ)	Low	2, 1-liter polyethylene bottles	metals** HNO <sub>3</sub> to pH<2, cool Cyanide NaOH to pH>12, cool	90%	Same as Organic (AQ)
Organic (S)	Low	2, 120-ml glass vials (organic)	Cool, 4° C.	100%	Same as Organic (AQ)
Inorganic (S)	Low	and 2, 8-oz glass jars (inorganic) or 4, 4-oz glass jars	Cool, 4° C.	75-90%	

AQ - Aqueous; S - solid; L- liter

\* Two (2) VOA vials require only one (1) tag.  
\*\* Filter monitoring well sample before fixing.

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TABLE 3-4  
PARAMETER TABLE

<u>Parameter</u>	<u>Sample Matrix</u>	<u>Analy. Meth. Reference</u>	<u>Holding Time</u>
Volatile Organic Analysis	Soil	CLP(a)	10 days(c)
BNA PCB/Pesticide	Soil	CLP(a)	10 days till extrac- tion; 40 days till analysis(c)
Volatile Organic Analysis	Aqueous	CLP(a)	5 days(c)
Metals Cyanide	Soil	CLP(b)	6 mos.(c) Hg-28 days(c) CN-14 days(c)
BNA PCB/Pesticide	Aqueous	CLP(a)	5 days till extraction; 40 days till analysis(c)
Metals	Aqueous	CLP(b)	6 mos.(c) Hg-28 days(c)
Cyanide	Aqueous	CLP(b)	14 days(c) NaOH to ph>12
Total Organic Carbon (TOC)	Aqueous	EPA Method 415.2	28 days
Alkalinity	Aqueous		14 days

(a) Analysis will be performed in accordance with U.S. EPA Contract Laboratory Program, Statement of Work; Organic Analysis. Multimedia, Multi-Concentration Statement of Work (SOW) 7/85 WA#85-J680.

(b) Analysis will be performed in accordance with U.S. EPA Contract Laboratory Program, Statement of Work; Inorganic Analysis. Multimedia, Multi-Concentration Statement of Work (SOW) 7/85 WA#85-J868.

(c) Holding time based on CLP contractual holding times.

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- (4) With the exception of samples to be filtered (see Table 3-3), fill bottles directly. Bottle filling procedure will be the same for partial HSL as with full HSL analyses. For aqueous samples, first fill two (2) 40-ml glass vials for Volatile Organic Analysis (VOA) so that no air space or bubbles exist. Next fill two (2) half gallon amber bottles or four (4) 1-liter amber bottles (AQ extractables Acid/Base Neutral Acids (BNA)). Lastly, fill two (2) 1-liter polyethylene bottles for inorganics to 80 to 90% capacity. For laboratory soil samples, first fill two (2) 120-ml glass vials followed by two (2) 8-oz glass jars or four (4) 4-oz glass jars. Use same order even if only taking selected parameters.
- (5) Samples for soluble metals analysis will be filtered as soon as possible after collection using dedicated (disposable) filtering equipment and 0.45 micron filters.
- (6) Preserve samples with specified fixatives (see Table 3-3). Check with pH paper.
- (7) Field label each bottle using the predetermined location coding specified in Table 3-5.

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TABLE 3-5  
SAMPLE CODING

Each sample collected will have a 12 digit code identifying:

- o CC - Site Name Prefix (2 spaces)
- o Sample Matrix (2 spaces)
- o Location of Sample (3 spaces)
- o Sample interval or round (5 spaces)

Sample matrix codes include:

- o HW - Home (Ground Water) Sample
- o MW - Ground Water (Monitor Well) Sample
- o SS - Stream Sediment Sample
- o SW - Surface Water Sample
- o US - Shallow Soil Sample
- o WS - Soil Sample (Well Drilling)
- o SG - Soil Gas Sample

Location of sample can be specified as the monitor well number or as a designated location number for that sample. Location numbers will correlate to locations mapped in the field.

Sample interval is for soil samples (US or WS) only. For other samples it will be the round of sampling.

	<u>SITE</u>	<u>MATRIX</u>	<u>LOCATION</u>	<u>SAMPLE INTERVAL OR ROUND</u>
Soil Sample	CC	WS	012	05-10 (depth)
Ground Water	CC	MW	012	00001 (sample round)
Surface Water	CC	SW	001	00001 (sample round)
Home Well	CC	HW	001	00001 (sample round)

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- (8) Decontaminate the exterior of the sample bottles by rinsing them with Alconox and tap water, taking care not to wash off the field labels.
- (9) Label each bottle with an SMO sample tag as shown in Figure 3-5 (exception: the 2 VOA vials get a single sample tag) and an adhesive sample number from the appropriate Traffic Report (see Figures 3-6 and 3-7).
- (10) Prepare one organic and one inorganic Traffic Report (see Figures 3-6 and 3-7) for each sample set of bottles. Record VOA, BNA/Extr., and PCB/Pesticide samples on the organic report, and metals and cyanide on the inorganic report. Record the matching Traffic Report Number on both the inorganics and organics report for each sample set.
- (11) Enclose the sample containers in clear plastic bags through which the sample tags and labels are visible.
- (12) Carefully pack the samples in waterproof, metal and/or plastic ice chests or coolers packed with ice (contained in plastic bags) and styrofoam chips so that the sample containers will not make contact during shipment via vehicle.

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## Custody Seal

**CUSTODY SEAL**

Date \_\_\_\_\_

Signature \_\_\_\_\_

## Sample Tag

Project Code	Station No.	Month/Day/Year	Time	Designate:	
				Comp.	Grab
Station Location		Samplers (Signatures)			
<div style="display: flex; justify-content: space-between;"> <div>Tag No. <b>3-159657</b></div> <div>Lab Sample No.</div> </div>		ANALYSES			
		Preservative: Yes <input type="checkbox"/> No <input type="checkbox"/>			
		BOD	Anions		
		Solids - (TSS) (TDS) (SS)			
		COD, TOC, Nutrients			
		Phenolics			
		Mercury			
		Metals			
		Cyanide			
		Oil and Grease			
Organics GC/MS					
Priority Pollutants					
Volatile Organics					
Pesticides					
Mutagenicity					
Bacteriology					
Remarks:					

☆ GPO 606-467

FIGURE 3-5

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CHAIN OF CUSTODY SEAL AND SAMPLE MANAGEMENT OFFICE TAG

[illegible]

Delivered by: \_\_\_\_\_ Received by: \_\_\_\_\_

Date/Time: \_\_\_\_\_ Date/Time: \_\_\_\_\_

Provide Results to: \_\_\_\_\_ at \_\_\_\_\_

**Deadline:**

Notes:

JACA Corporation ·  
550 Pinetown Road  
Ft. Washington, PA 19034  
(215) 643-5466

JACA P.O.#

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Delivered by: \_\_\_\_\_  
Received by: \_\_\_\_\_

Date/Time: \_\_\_\_\_ Date/Time: \_\_\_\_\_

Provide Results to: \_\_\_\_\_ at \_\_\_\_\_.

**Deadline:**

Notes:

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550 Pinetown Road  
Ft. Washington, PA 19034  
(215) 643-5466

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- (13) Ship the bottom two (2) copies of each Traffic Report to the lab with the appropriate samples along with the top two copies of Chain of Custody form (Figure 3-8), listing all samples.  
Enclose the Traffic Reports and Chain-of-Custody Records in a waterproof plastic bag and tape them to the underside of the cooler lid.
- (14) Seal the cooler with custody seals (see Figure 3-5) in such a manner that the custody seal would be broken if the cooler were opened.
- (15) Add clearly visible return address labels on the outside and "This End Up" labels on all four sides of the cooler.
- (16) Ship samples the same day they are collected unless previous arrangements are made. Alert the shipping service of the restricted articles prior to pick-up.
- (17) Fill out one air bill (Figure 3-9) for all shipments with the same destination.
- (18) Mail the top copy of each Traffic Report to QC Laboratory as soon as possible together with a completed Sample Shipment Log (see Figure 3-10).

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JACA P.O.#

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Delivered by: \_\_\_\_\_ Received by: \_\_\_\_\_

Date/Time: \_\_\_\_\_

Provide Results to: \_\_\_\_\_ at \_\_\_\_\_

**Deadline:**

Notes:

JACA Corporation ·  
550 Pinetown Road  
Ft. Washington, PA 19034  
(215) 643-5466



1000,

PLEASE PRINT OR TYPE

ORIGIN ACCOUNTING COPY

- (19) Mail the top copy of each Traffic Report to QC Laboratory as soon as possible together with a completed Sample Shipment Log (see Figure 3-10).

#### 3.12.4 Equipment

- o CLP documentation forms
- o Waterproof markers
- o Sample bottles
- o Preservatives including ice
- o Filtering apparatus
- o Metal shipping coolers
- o Bubble-pack
- o Decontamination supplies

#### 3.13 Biological Description

##### 3.13.1 Objectives

The CryoChem property will have its wetlands delineated. The surrounding study area will be described in general to point out the various plant communities which could be affected by the project.

##### 3.13.2 Scope

Walk through CryoChem property and field flag and describe the general wetlands plant communities. The surrounding area will be hiked and driven to classify and describe general plant communities.

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[illegible]

Delivered by: \_\_\_\_\_  
Received by: \_\_\_\_\_

Date/Time: \_\_\_\_\_

Provide Results to: \_\_\_\_\_ at \_\_\_\_\_

Deadline: \_\_\_\_\_

Notes: \_\_\_\_\_

JACA Corporation ·  
550 Pinetown Road  
Ft. Washington, PA 19034  
(215) 643-5466

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### 3.13.3 Protocol

A biologist, wearing Class D clothing, and rubber boots will walk the CryoChem Inc. property, placing red flags at the periphery of the wetlands habitat. Each isolated wetlands area will be described noting its plant community, drainage characteristics and general benefit as wildlife habitat.

The area surrounding CryoChem Inc. will be walked and driven to locate any significant wetlands areas and define general plant communities. The general communities will be transferred onto aerial photographs to note their locations.

### 3.13.4 Equipment

- o Aerial photographs
- o Flags
- o Notebook
- o Camera
- o Marking pens/labels
- o Sampling envelopes
- o Identification book

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#### 4.1 Project Organization

JACA Corp. is the prime contractor for the REM II Program and is the lead firm for the CryoChem site RI/FS and will provide management, quality control, and technical services. Quality Control Laboratory (Q.C. Labs) will provide the laboratory analysis services. The EPA and PA DER will provide community relations activities.

To facilitate clear lines of communication for field activities, Table 4-1 lists key project contacts, their roles in the project, their office telephone numbrs, and an alternate contact. In the event that the required level of safety protection is upgraded, the site must be evacuated, or work is stopped for any reason, the field team leader will be responsible for immediately notifying the JACA Site Manager and the EPA Project Officer.

#### 4.2 Project Staffing and Schedule

Table 4-2 outlines that anticipated schedule of field activities and the staff tentatively assigned to these activities. These assignments may change depending on staff availability. Because of the long duration of the soil boring and well installation task in Phase II, staff may be rotated approximately every two weeks to reduce fatigue and help ensure complete field reporting.

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TABLE 4-1  
KEY PROJECT CONTACTS

CONTACT	PROJECT ROLE	AFFILIATION	TELEPHONE NO.	ALTERNATE CONTACT
Albert Gray	Project Coordinator	JACA Environmental Consultants	(215) 643-5466	Uday Patankar
Andrea Russiello	Health & Safety Coordinator	JACA Environmental Consultants	(215) 643-5466	Daniel Rhue
Ronald Putt	Site Owner	CryoChem President	(215) 689-6131	Victor Dodd
Nicky Holt	Laboratory Coordinator	Quality Control Labs	(215) 674-8830	Robert Hurst

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#### 4.3 Site Access and Facilities

All site entry will be through the main gate. All personnel entering the site will be logged in and out on a daily basis by the field team leader.

#### 4.4 Daily Log

It is the responsibility of the Field Team Leader or his designee to prepare a daily log of site activities. The log should document:

- o Arrival and departure times;
- o Conditions of site upon arrival;
- o Personnel on-site, including visitors;
- o Activities accomplished;
- o Problems encountered.

It will also be the responsibility of the Field Team Leader to suspend activities in situations where effective and safe field operations cannot be assured. These actions must be documented in the daily log.

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## 5.0 QUALITY ASSURANCE PROJECT PLAN

### 5.1 Introduction

This section represents the Quality Assurance Project Plan (QAPP) for the CryoChem site located in Worman, Pennsylvania. It has been prepared in compliance with the USEPA Administrator's memorandum of May 30, 1979 requiring the preparation of QAPPs for all monitoring and measurement activities that generate and process environmentally related data for the agency's use.

To the extent applicable to the CryoChem project this QAPP has also been prepared in accordance with the requirements of the REM II Quality Assurance Program Plan (Document No. 999-QC1-RT-ACAB-3) and the following guidelines established by the USEPA and the REM II quality assurance program management, respectively:

- o USEPA. February 1983. Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans, EPA-600/4 - 83-004.
- o CDM Team. June 1985. Generic Guidance for Quality Assurance Project Plans, Document No.: 999-QC1-QA-AVXN-3.

This document specifies the procedures which must be implemented to assure that data gathered at the CryoChem site are consistent with specific quality goals of accuracy, precision, completeness, and representativeness.

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## 5.2 Project Description

The site location and history and the description of this RI/FS project for CryoChem are presented in Sections 1 and 2 of this Sampling and Analysis Plan (SAP). The scope of the sampling and analysis program is described in Section 3 of this document, and the project management plan for this RI/FS program is presented in Section 4.

## 5.3 Project Organization and Responsibility

### 5.3.1 Project Organization

The project organization and responsibilities for the CryoChem site are described in Section 6 of the Work Plan (WP) and Section 4 of this Sampling and Analysis Plan (SAP) for the site. The project organizational chart is presented as Figure 5-1.

### 5.3.2 Quality Assurance Organization

#### 5.3.2.1 Quality Assurance Director

The Quality Assurance Director (QAD) is responsible for all aspects of the Quality Assurance Program Plan. Responsibilities include approval of quality assurance procedures, conducting system and performance audits, and seeing that Quality Assurance personnel are trained.

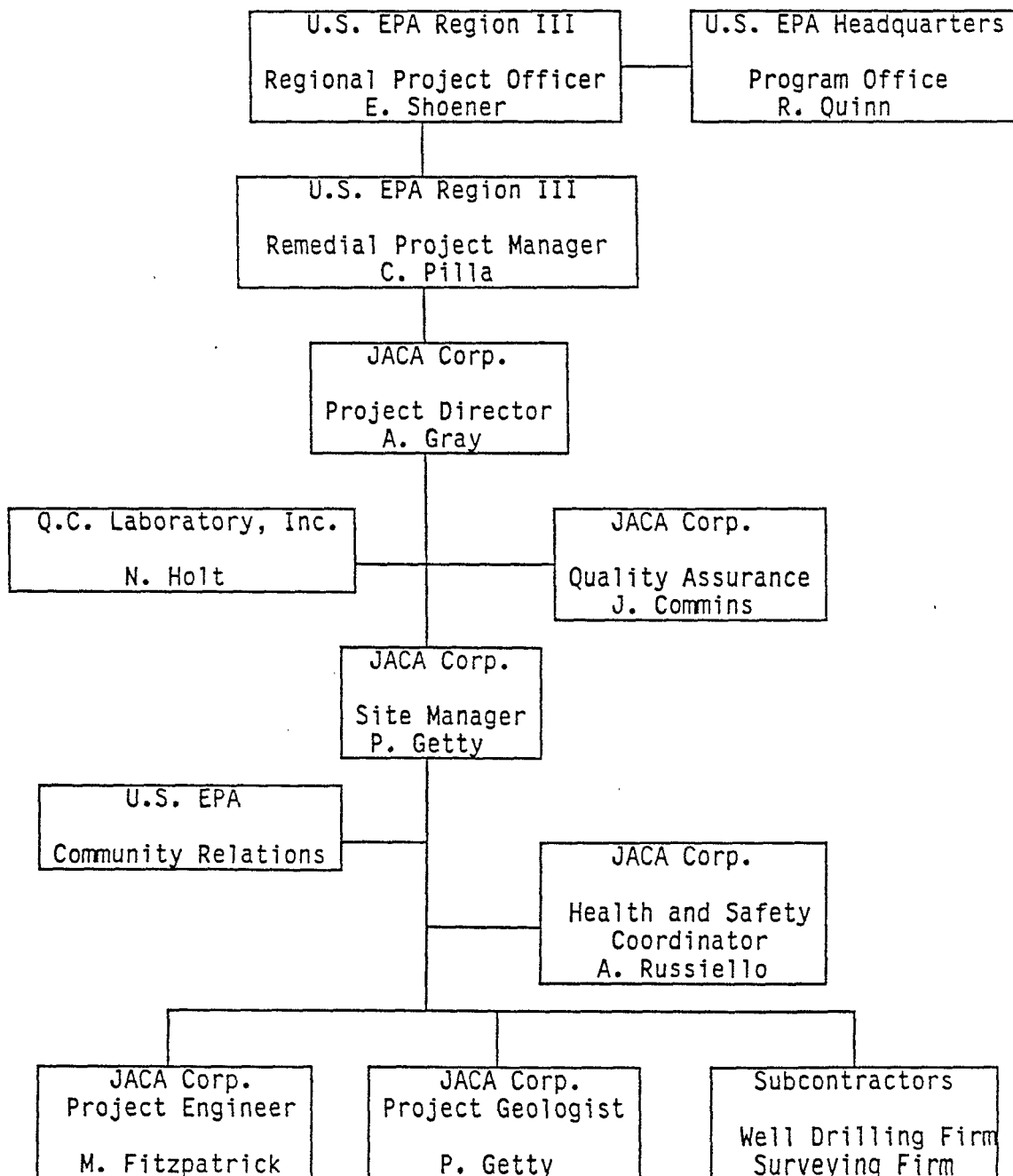
The Quality Assurance Director's specific responsibilities include:

- o Planning, implementing, and administering the quality assurance program.

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FIGURE 5-1  
ORGANIZATIONAL CHART



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- o Interfacing with EPA on quality assurance matters.
- o Reviewing procedures at least once a year with EPA to ensure consistency with quality assurance objectives and continued conformance with applicable regulations.
- o Auditing the overall performance of the quality assurance program, and developing a plan for regularly monitoring the quality aspects of hazardous waste management activities.
- o To ensure program control of documents and implementation of procedures.
- o Preparing a monthly report on the status of the quality assurance program. This report will include summaries of audit findings and corrective actions.
- o Working with all levels of personnel to identify and eliminate potential quality assurance problems.

#### 5.4 Quality Assurance Objectives for Measurement Data

Quality assurance objectives for measurement data are usually expressed in terms of accuracy, precision, completeness, representativeness, and comparability. Definitions of these characteristics are as follows:

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- o Accuracy - the degree of agreement of a measurement (or an average of measurements),  $X$ , with an accepted reference or true value,  $T$ . This agreement is usually expressed as the difference between the two values,  $X-T$ , or as a percentage of the reference or true value,  $100(X-T)/T$ . It may sometimes be expressed as a ratio,  $X/T$ . Accuracy is a measure of the bias in a system.
- o Precision - a measure of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions. Precision is best expressed in terms of the standard deviation. Various measures of precision exist depending upon the "prescribed similar conditions."
- o Completeness - a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under normal conditions.
- o Representativeness - expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter, variations at a sampling point, a process condition, or an environmental condition.
- o Comparability - expresses the confidence with which one data set can be compared to another.

The data quality objectives of this project are generally those specified in the CLP contract and in the subcontractor's scope of work for non-CLP analyses.

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## 5.5 Quality Assurance for Sampling Procedures

Site-specific sampling procedures to be used at the CryoChem site are described fully within Section 3.0 of this Sampling and Analysis Plan. The sampling procedures generally follow those documented in the REM II Site Investigation Procedures Manual (SIPM) or similar reference document.

## 5.6 Sample and Document Custody Procedures

### 5.6.1 Sample Custody

Samples will be handled in accordance with the general programmatic procedures established in Sections L and M of the REM II Quality Assurance Program Plan. Section L covers the requirements for handling, storage, and shipping of samples; and Section M, chain-of-custody. The SIPM procedures referenced in these sections are listed in Table 5-1. Site-specific procedures are described in Section 3.12 of this Sampling and Analysis Plan.

### 5.6.2 Document Custody

Document control procedures will follow those established in Sections C, F, and H of the REM II Quality Assurance Program Plan. These control procedures cover the following documents:

- o Working Documents and Deliverables

- All working documents designated in the Work Plan
- All working documents required for the production deliverables

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TABLE 5-1  
SAMPLE CUSTODY PROCEDURES

<u>Procedure Title</u>	<u>SIPM Method Number</u>
<u>Section L of QA Program Plan</u>	
Sample Handling and Classification	5622001
Field Notebooks	5621004
Site Location Procedure and Photographic Evidence	5622003
Sample Identification	5622002
Sample Container Labeling	5622004
Sample Bottle Preparation, Preservation, and Maximum Hold Times	5622006
Samples Collected for Quality Control Purposes	5622007
Chain of Custody	Section 3.12 of this document

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- o Facility Design Documents
  - Completed design documents
- o Equipment/Services Procurement Documents
  - Supplies
  - Subcontractors

All working documents and deliverables for the CryoChem site will be assigned a specific document control number. Tracking forms will be attached to these documents. The forms will record the routing of the document and review procedures prior to incorporation into the central file system. Central files will be maintained by the project team and contain copies of all draft and final documents relating to the CryoChem RI/FS.

## 5.7 Calibration Procedures and Frequency

### 5.7.1 Field Calibration Procedures

Site-specific calibration procedures for field instruments are specified in the other sections of this Sampling and Analysis Plan. Among these are the SIPM procedures listed in Table 5-2. An equipment calibration schedule is provided in Table 5-3.

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TABLE 5-2  
STANDARD CALIBRATION PROCEDURES

<u>Instrument/Equipment</u>	<u>Standard Method Number<sup>(1)</sup></u>
HNu PI 101	6607001
OVA-128	6607003
YSI Model 33 S-C-T Meter	6617002
Haake Buchler pH Stick	6616003
In-situ SE 1000 Hydrologic Monitor	"Non-standard"

---

NOTE:

(1) Standard SIPM Method Number listed from REM II QA Program Plan.  
"Non-Standard" Calibration techniques described for each instrument/  
equipment in other sections of this Sampling and Analysis Plan.

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TABLE 5-3  
EQUIPMENT CALIBRATION SCHEDULE

<u>Instrument</u>	<u>Schedule</u>
PID	Calibrate <sup>1</sup> frequently; daily before use
FID	Calibrate <sup>1</sup> frequently; daily before use
G/C	Upon set up and after every 10 samples

---

<sup>1</sup>All instruments to be calibrated according to each specific manufacturer's recommendation and standard procedures as indicated in Table 5-2.

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#### 5.7.2 Laboratory Calibration Procedures

The calibration procedures and frequency of calibration will follow the specifications of the Contract Laboratory Program (CLP) or EPA approved specifications. For analyses, the use and frequency of these procedures will be verified during the laboratory site evaluations performed yearly by personnel of the EPA National Program Office, Region III, and the Environmental Monitoring Systems Laboratory/Las Vegas. JACA's subcontractor laboratory, QC Inc., will submit documentation on analysis of performance evaluation samples before field sampling is initiated.

#### 5.8 Analytical Procedures

General programmatic requirements for analytical procedures are established in Sections E and N of the REM II Quality Assurance Program Plan. Section E establishes the need for formally documented procedures. Section N requires:

- o The specification of analytical procedures in the SAP for all engineering data (screening field samples, pilot laboratory studies) and non-CLP generated data.

EPA approved analytical procedures will be used for samples to be analyzed by subcontracted environmental laboratories. Other analytical procedures must be thoroughly documented. The Quality Assurance Plan for the subcontractor laboratory to be used for the CryoChem RI/FS is included in Appendix B.

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#### 5.9 Data Reduction, Validation, and Reporting

Data reduction, validation, and reporting will be performed in accordance with the general requirements established in Section G of the REM II Quality Assurance Program Plan. QC Laboratories, Inc., JACA's subcontractor laboratory will perform data reduction and validation.

#### 5.10 Internal Quality Control Checks

General programmatic requirements for internal quality control checks are established in Sections E, J, and P of the REM II Quality Assurance Program Plan. Section E lists a number of Standard Operation Procedures (SOP) on sample collection and quality control which are found in Section 3.0 of the Site Investigation Procedures Manual (SIPM). Section J lists the types of technical reviews required for quality control of deliverables. Section P establishes the requirements for controlling nonconformances and the related internal quality control checks.

Samples that will be collected for QA/QC purposes include trip blanks, field blanks and duplicate samples. A trip blank consists of a set of sample containers filled with laboratory demonstrated analyte free water. These trip blanks should be handled, transported, and analyzed in

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the same manner as the samples acquired that day. A field blank consists of two sets of laboratory-cleaned sample containers. One set of containers is empty and will serve as the sample container that will be analyzed. The second set of containers are filled at the laboratory with laboratory demonstrated analyte free water. At the field location, this analyte free water is then passed through laboratory-cleaned sample equipment and placed in the empty set of sample containers for analysis. At selected stations in a random time-frame, duplicate samples (two samples) are collected from the same sampling location at the same time. This provides a check of sampling equipment and technique for precision.

Typically, one trip blank will be provided for each shipment containing samples for VOC analysis. Field blanks will typically be collected at a frequency of one per every 20 samples (5 percent). Equipment blanks will be collected following a representative decontamination procedure for each type of sampling equipment. Duplicate samples will typically be collected at a frequency of one per every 10 samples (10 percent).

#### 5.10.1 Sampling and Laboratory Procedures

There are two types of quality assurance mechanisms used by the laboratory to ensure the production of analytical data of known and documented usable quality: analytical method quality control (QC), and program quality assurance (QA). The internal quality control procedures for routine analytical services are specified in the laboratory QA/QC manual.

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These specifications include the types of audits required (sample spikes, surrogate spikes, reference samples, controls, blanks), the frequency of each audit, the compounds to be used for sample spikes and surrogate spikes, and the quality control acceptance criteria for these audits.

#### 5.10.2 Deliverables

Site-specific internal QC checks for deliverables will be implemented as established in the Work Plan. These pertain to a single person and committee review of the document and final sign-off requirements.

#### 5.11 Performance and Systems Audits

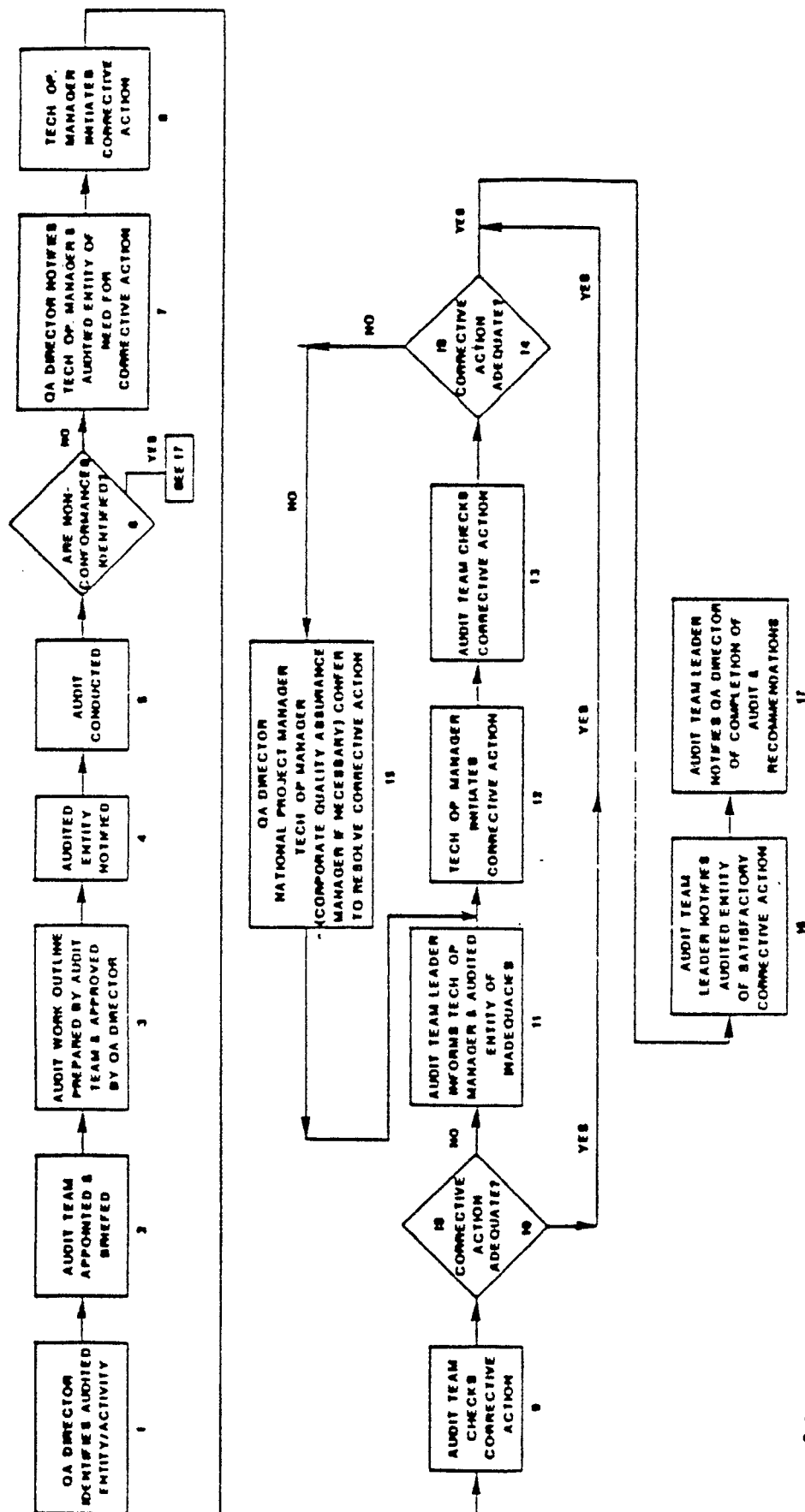
Audits are initiated by the Quality Assurance Director (QAD). The general procedure for performing an audit is summarized in Audit Flow Chart which is reproduced as Figure 5-2. The JACA QAD for this project is a principal of the firm and has frequently served in this capacity on various JACA projects.

##### 5.11.1 System Audits

System audits will be carried out to verify that:

- o The necessary procedures of the Work Plan, Remedial Investigation, and Feasibility Study phases are established.
- o The reviews and sign-offs required in EPA procedures are being implemented.

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**FIGURE 5-2 AUDIT FLOW CHART**

#### 5.11.2 Performance Audits

Performance audits involve on-site field investigation procedures audits, observation/interviewing of technical staff office activities, and/or laboratory visits to verify conformance with EPA procedures established in the site planning documents.

#### 5.12 Preventive Maintenance

Preventive maintenance of field monitoring equipment used at the CryoChem site will be conducted as specified by EPA. A schedule of field equipment maintenance for this site is presented in Table 5-4.

#### 5.13 Data Measurement Assessment Procedures

The assessment of data measurements is an activity that affects data quality. In accordance with Section E of the REM II Quality Assurance Program Plan, formally documented procedures must therefore be established for data measurement assessment.

Section 5.6 of the REM II Technical Operations Manual (TOM) requires that data measurement assessment procedures be provided in the Project Operations Plan (POP). The Work Plan and Sampling Analysis Plan describe data measurements and evaluation procedures for the CryoChem site.

#### 5.14 Corrective Action

All nonconformances with the established quality control procedures will be identified and controlled. Additional work which is dependent on

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TABLE 5-4  
EQUIPMENT MAINTENANCE SCHEDULE

<u>Equipment</u>	<u>Maintenance</u>
HNu PI 101	Charging daily (14 hours)
Specific Conductance	Check battery daily
pH - Electrometric Method	Check battery daily
OVA	Check gas cylinder daily
Full-face Respirator	Wash and inspect daily

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the nonconforming activity will be performed until the nonconformance is corrected.

Corrective actions will be implemented and documented in accordance with Section Q of the REM II Quality Assurance Program Plan or subsequent QA guidance issued by the QAD. Corrective Actions will be defined and implemented to the satisfaction of the Quality Assurance Director. A summary of the procedure for correcting nonconformance is depicted in Figure 5-4, Audit Flow Chart.

#### 5.15 Quality Assurance Reports to Management

The Quality Assurance director or his designee, will review the implementation of this Quality Assurance Project Plan on a regular monthly (normally) basis and review periodic summary reports with the project manager. These reviews will include an assessment of data quality, deliverables, QC activities, and the results of systems and/or performance audits as appropriate.

#### 5.16 Quality Assurance References

REM II Team. October 1984. REM II Quality Assurance Program Plan.

Performance of Remedial Response Activities at Uncontrolled Hazardous Waste Sites. Document No. 999-QC1-RT-ACAB-3.

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REM II Team. December 1984. REM II Site Investigation Procedures Manual (Draft). Performance of Remedial Response Activities at Uncontrolled Hazardous Waste Sites. Document No. 999-PM1-IO-BRNL-1.

REM II Team. April 1985. REM II Technical Operations Manual. Performance of Remedial Activities at Uncontrolled Hazardous Waste Sites. Document No. 999-TS1-RT-ASSK-3.

Muldoon, Donald. July 1984. REM II Data Validation Procedure. Memorandum to Gary Dunbar. Document No. 999-PM1-IO-AEGQ-1.

USATHAMA. March 1983. Analytical Methods. Descriptions.

USEPA. March 1979. Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-02.

USEPA. February 1983. Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans. EPA-600/4-83-004.

USEPA. 1983. Test Methods for Evaluation Solid Waste, Physical/Chemical Methods, SW-846.

USEPA. July 1984. User's Guide to the Contract Laboratory Program.

REM II Team. June 1987. Draft Work Plan, CryoChem site, Worman, PA, Remedial Investigation/Feasibility Study. Document Control Number: 383-PP1-WP-EPVE.

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## 5.17 Glossary of Terms for Quality Assurance

### Audit:

A systematic check to determine the quality of operation of some function or activity. Audits may be of two basic types: (1) system audits that consist of a review of the quality control system to ensure that a comprehensive set of quality control methods, procedures, reviews, and sign-off approvals is established or in place, and (2) performance audits in which project activities are observed in process for their compliance with the established quality control procedures and requirements.

### Data Validation:

A systematic process for reviewing a body of data against a set of criteria to provide assurance that the data are adequate for their intended use. Data validation consists of data editing, screening, checking, auditing, verification, certification, and review.

### Environmentally Related Measurements:

A term used to describe essentially all field and laboratory investigations that generate data involving (1) the measurement of chemical, physical, or biological parameters in the environment; (2) the determination of the presence or absence of pollutants in waste streams; (3) assessment of health and ecological effect studies; (4) conduct

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of clinical and epidemiological investigations; (5) performance of engineering and process evaluations; (6) study of laboratory simulation of environmental events; and (7) study or measurement of pollutant transport and fate, including diffusion models.

#### Quality Assurance:

The total integrated program for assuring the reliability of monitoring and measurement data. A system for integrating the quality planning, quality assessment, and quality improvement effort to meet user requirements.

#### Quality Assurance Program Plan:

An orderly assemblage of management policies, objectives, and principles, and general procedures by which an agency or laboratory outlines how it intends to produce data of known and accepted quality.

#### Quality Assurance Project Plan:

An orderly assembly of detailed and specific procedures which delineates how data of known and accepted quality are produced for a specific project. (A given agency or laboratory would have only one quality assurance program plan, but would have a quality assurance project plan for each of its projects.)

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Quality Control:

The routine application of procedures for obtaining prescribed standards of performance in the monitoring and measurement process.

Standard Operating Procedure (SOP):

A written document which details an operation, analysis, or action whose mechanisms are thoroughly prescribed and which is commonly accepted as the method for performing certain routine or repetitive tasks.

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APPENDIX A  
STANDARD OPERATING PROCEDURES

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## PROCEDURE A1: SPECIFIC CONDUCTIVITY MEASUREMENT

### A1.1 Discussion

This details the steps required to measure the specific conductance of an aqueous sample while in the field. It is important to obtain a specific conductance measurement soon after taking a sample in that temperature changes, precipitation reactions, and adsorption of carbon dioxide from the air all affect the specific conductance.

Conductivity is a numerical expression of the ability of a water sample to carry an electrical current. This value depends of the total concentration of the ionized substances dissolved in the water and the temperature at which the measurement is made. The mobility of each of the dissolved ions, their valences, and their actual and relative concentrations affect conductivity.

Most inorganic acids, bases, and salts (such as hydrochloric acid, sodium carbonate, and sodium chloride) are relatively good conductors.

Conversely, molecules of such organic compounds as sucrose and benzene, which do not dissociate in aqueous solution, conduct a current very poorly, if at all.

### A1.2 Field Measurements of Conductivity Protocol

The steps involved in taking specific conductance measurements are listed below.

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1. Immerse the electrode in water overnight. If this is not possible due to field conditions, immerse the electrode for at least an hour before use.
2. Rinse the cell with one or more portions of the sample to be tested.
3. Immerse the electrode in the sample and measure the conductivity.
4. Read and record the results. Adjust the temperature setting to the sample temperature.
5. Three readings should be collected for each sample.

All results are to be recorded in the field notebook.

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## PROCEDURE A2: FIELD pH MEASUREMENTS

### A2.1 Discussion

This guideline details the steps required to measure the pH of an aqueous sample in the field using both a pH meter and pH paper. It is important to obtain a pH measurement immediately after taking a sample and thus void sample changes such as precipitation, temperature fluctuation, or oxidation which can affect the pH of the sample.

Two methods are given for pH measurement: the pH meter and pH indicator paper. The indicator paper is used when only a rough estimate of the pH is required and the pH meter when a more accurate measurement is needed. Use of the pH meter is the preferred method. To use the pH meter, the meter and electrode are standardized in pH 7 buffer and then immersed in the unknown sample to obtain a pH reading. No standardization is required when using pH paper. The indicator paper is simply immersed in the sample, and then a color comparison is made.

### A2.2 pH Meter Measurement Protocol

The following procedure is used for measuring pH with a pH meter:

1. Immerse the tip of the electrode in water overnight. If this is not possible due to field conditions, immerse the electrode tip in water at least an hour before use.
2. Rinse the electrode with demineralized water.
3. Immerse the electrode in pH 7 buffer solution.

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4. Adjust the temperature compensator to the proper temperature.
5. Adjust the pH meter to read 7.0 (Note: If the sample is known to have a very acidic or alkaline pH, standardize the meter with pH 4 or pH 10 buffer, respectively.)
6. Remove the electrode from the buffer and rinse with demineralized water.
7. Immerse and electrode in the unknown solution.
8. Read and record the pH of the solution, after adjusting the temperature compensator to the sample temperature.
9. Rinse the electrodes with demineralized water.
10. Three readings should be collected for each sample.
11. Keep the electrode immersed in water when not in use.

#### A2.3 INDICATOR PAPER MEASUREMENT PROTOCOL

The following procedure is used for measuring pH with indicator paper:

1. Immerse a strip of indicator paper into the unknown solution.
2. Remove the paper from the solution and compare the color with the indicator colors given on the pH paper container.
3. Record the pH. (Note: If the indicator paper is suspected of being oil or deteriorated, immerse it in pH 7 buffer and check the color that develops against the standards given.

To check acid-preserved samples to confirm that pH of the preserved sample is required, the following procedures should be used. This procedure is performed after the preservative has been added to sample and has been well mixed by closing container and investing several times.

1. Remove the cap from container.
2. Immerse clean glass rod into rpreserved sample. Remove rod and touch it with pH paper of appropriate sensitivity.
3. If pH is determined to be correct, close container.
4. If pH levels needs further adjustment, add additional preservative and recheck pH.
5. Clean glass rod with soap and water, rinse with DI water.

All results are to be recorded in the field notebook.

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## PROCEDURE A3: HANDLING AND MARKING OF CORE SAMPLES

### A3.1 Discussion

Standard procedures will be followed for handling and describing core samples.

### A3.2 Protocol

- (1) Lay core out with top away from you, pieced together.
- (2) Mark T on top piece of core.
- (3) Mark red and black stripes from top to bottom of core (with red on right when standing at bottom of core). Make sure pieces of core are fitted together before striping core.
- (4) Mark blue line on bedding dip direction if in non-horizontal sediments. Bedding dip direction is easily identifiable as the lowest point of a given bedding plane on a piece of core.
- (5) Put tape on core and mark each foot beginning where the coring was started. Top of core will not necessarily be exactly on a foot mark.
- (6) Put core in boxes marked with core hole number or well number, depth interval of core in that box and box number (i.e., 3 of 10).
- (7) Compute core recovery and enter in field notebook and on Table A2-1. Enter description of core on Table A2-1 using legend

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shown in Table A2-2. Core recovery equals total core recovered divided by total cored interval. Lost core is assumed to be lost at the bottom.

Note: A grease pencil and indelible ink pens both work for marking cores. It may help to wipe the core down and dry it before marking. Marking of core should occur prior to any handling or description.

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Table A3-1

FRACTURE DESCRIPTION LEGEND

TYPE

- 1 - Penetrative\* natural fracture
- 2 - Non penetrative natural fracture
- 3 - Filled fracture (mineralization)
- 4 - Induced fracture

\*Penetrative refers to whether the fracture penetrates the core sample and can therefore be traced all the way around the core.

DIP - Angle deviation from horizontal (i.e., horizontal = 0; vertical = 90)

POROSITY

- 1 - Totally open
- 2 - Partially open (vugs or crack)
- 3 - Filled

FRACTURES PER FOOT - Number of fractures per foot for a given set of parallel fractures of the same type.

LITHOLOGY

- SH - Shale
- SLT - siltstone
- SS - sandstone (VF, F, M, C,)
- LS - limestone
- DOL - dolomite

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FRACTURE DESCRIPTION SHEET

[illegible]

## PROCEDURE A4: USING AND CALIBRATING WATER PRESSURE TRANSDUCERS

### A4.1 Discussion

Pressure transducers are devices that measure hydrostatic pressure which can then be converted to ground water elevations. A transducer is designed to measure pressures over a specific range of submergence. Outside of this range, measurements will not be accurate, and the transducer can be damaged if submerged more than two times its design range or if subjected to negative pressures. The Scale Factor (SF) for a transducer is the actual range of accurate measurements and is typically close to the design range.

Several precautions should be taken in using transducers in addition to limiting the depth of submergence. First, the transducer cable is vented so that temperature and barometric pressure will not cause variations in the transducer reading. If the vent port is plugged, inaccurate readings will result. If water enters the vent and flows downward into the transducer, the transducer may be destroyed. Transducer cable is susceptible to both physical damage (e.g., abrasion on sharp well casings) and chemical degradation from solvents. If the cable is damaged and submerged, the transducer may be destroyed.

### A4.2 Protocol

- (1) Cover sharp edges of the well casing with duct tape to protect the transducer cables.
- (2) Install the transducer and cable in the well to a depth below the target drawdown estimated for the test but at least two feet

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from the bottom of the well. Be sure this depth of submergence is within the design range stamped on the transducer. Mark this depth on the cable using a piece of duct tape.

- (3) Withdraw the transducer and cable an accurately measured distance between two and five feet. Mark this depth on the cable using a piece of duct tape. Temporarily tape the transducer cable to the well to keep the transducer at a constant depth.
- (4) Connect the transducer cable to the recording device (e.g., Datalogger, Hermit, SE-200).
- (5) Enter the initial water level and transducer design range into the recording device according to manufacturers instructions (the transducer design range will be stamped on the side of the transducer). Record the initial water level on the recording device.
- (6) Lower the transducer the distance measured in step 3. Record the change in water levels given on the recording device.
- (7) Calculate a corrected transducer scale factor ( $SC_2$ ) as follows:

$$SC_2 = SC_1 \times (L/W)$$

where

$SC_1$  is the initial transducer design range stamped on the transducer.

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L is the distance that the transducer is lowered during calibration, measured in step 3.

W is the difference between the two water level measurements on the recording device.

- (8) Input the corrected transducer scale factor, ( $SC_2$ ) into the recording device. If the difference between the two, scale factor ( $SC_2 - SC_1$ ) is considerably more than  $1\frac{1}{2}$  of the design range than repeat steps 5 through 7. If the recalculated scale factors are not similar to each other after three attempts, replace and transducer.

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## PROCEDURE A5: DISSOLVED OXYGEN MEASUREMENTS

### A5.1 Discussion

The dissolved oxygen (DO<sub>2</sub>) meter measurements amount of oxygen dissolved in a liquid. Measurements are usually expressed in mg/l values.

Procedure for taking DO<sub>2</sub> measurements:

- (1) Due to the wide range of available field instruments, the specific instructions for the available field instrument should be used.
- (2) Take at least two (2) measurements for each sample. Record results in field notebook.
- (3) Wash electrode set with distilled or deionized water after use.

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## PROCEDURE A6: REDOX potential (Eh) MEASUREMENTS

### A6.1 Discussion

The ability of a natural environment to bring about any oxidation or reduction process is measured by a quantity called redox potential. Experimentally, this is performed by immersing an inert electrode into a sample material and measuring the potential difference between the inert electrode and an electrode of known potential. Measurements are usually expressed  $10^{-3}$  volts (millivolts).

### A6.2 Redox Potential Measurement Protocol

- (1) Rinse the electrodes with distilled or deionized water.
- (2) Insert electrodes into the well to be measured.
- (3) Wait until meter stabilizes around a reading.
- (4) Record reading in field logbook.
- (5) Rinse electrode with distilled or deionized water.

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